CHAPTER - 8

BIODIVERSITY

Biodiversity found on Earth today consists of many millions of distinct biological species, the product of four billion years of evolution. Biodiversity is the variety of life on Earth, it includes all organisms, species, and populations; the genetic variation among these; and their complex assemblages of communities and ecosystems. It also refers to the interrelatedness of genes, species, and ecosystems and in turn, their interactions with the environment.

This is life, This is Biodiversity.

8.1. BIODIVERSITY

Biodiversity is defined as 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems'.

- United Nations Earth Summit (1992)

Conservation and sustainable use of biodiversity is fundamental to ecologically sustainable development. Biodiversity is part of our daily lives and livelihood, and constitutes resources upon which families, communities, nations and future generations depend.

Do you know?

India updated its National Biodiversity Action Plan (NBAP) and also developed 12 National Biodiversity Targets in 2014in line with 20 global Aichi biodiversity targets.

(a) Genetic diversity:

- It is concerned with the variation in genes within a particular species.
- Genetic diversity allows species to adapt to changing environments.
- This diversity aims to ensure that some species survive drastic changes and thus carry on desirable genes.
- The survival of individuals ensures the survival of the population.
- The genetic diversity gives us beautiful butterflies, roses, parakeets or coral in a myriad hues, shapes and sizes.

Do you know?

The Ministry has partnered with the United Nations Development Programme (UNDP) in a global project on Biodiversity Finance Initiative (BIOFIN).

(b) Species diversity:

- It refers to the variety of living organisms on earth.
- Species differ from one another, markedly in their genetic makeup, do not inter-breed in nature.
- Closely-related species however have in common much of their hereditary characteristics. For instance, about 98.4 per cent of the genes of humans and chimpanzees are the same.

- It is the ratio of one species population over total number of organisms across all species in the given biome.
- 'Zero' would be infinite diversity, and 'one' represents only one species present.

(c) Ecosystem/ Community diversity:

- This refers to the different types of habitats. A habitat is the cumulative factor of the climate, vegetation and geography of a region.
- There are several kinds of habitats around the world. Corals, grasslands, wetland, desert, mangrove and tropical rain forests are examples of ecosystems.
- Change in climatic conditions is accompanied by a change in vegetation as well. Each species adapts itself to a particular kind of environment.
- As the environment changes, species best adapted to that environment becomes predominant. Thus the variety or diversity of species in the ecosystem is influenced by the nature of the ecosystem.

Do you know?

Elephants live in a social hierarchy dominated by older females. Females travel in long-lasting social units of about half a dozen adult females and their offspring, with the unit being led by a single older female, the matriarch.

8.1.2. Measurement of Biodiversity

Biodiversity is measured by two major components:

i. species richness, and
ii. species evenness.

(i) Species richness

It is the measure of number of species found in a community

a) Alpha diversity

It refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem.

b) Beta diversity

It is a comparison of diversity between ecosystems, usually measured as the change in amount of species between the ecosystems

c) Gamma diversity

It is a measure of the overall diversity for the different ecosystems within a region.

(ii) Species evenness

It measures the proportion of species at a given site, e.g. low evenness indicates that a few species dominate the site.

Do you know?

The name 'white rhinoceros' is taken from the Afrikaans word describing its mouth: "weit", meaning "wide". Early English settlers in South Africa misinterpreted the "weit" for "white".

White rhinos are also sometimes called 'the square-lipped rhinoceros'. Their upper lip lacks the prehensile 'hook' of some of the other rhino species. The white rhino is the largest species of land mammal after the elephant.

8.1.3. Biodiversity and Food Web

The building blocks of plants, animals and humans are identical, and are made of the four elements - carbon, oxygen, nitrogen and hydrogen.

These elements are present in the environment - in air, water and soil. However, only green plants can absorb nitrogen from the soil through their roots, and use sunlight and water to produce energy by a process called photosynthesis. They are known as producers.

Animals and humans, who have plants or other animals as their food, are known as consumers. The chain that links consumers to producers is called the food chain or web.

Every living creature is found in a food chain. There are several food chains and they can be complex or simple depending on the environment.

To cite some examples, grasshoppers eat grass and are in turn eaten by frogs; snakes eat frogs and rodents.

Thus the importance of each and every creature in the web of life is evident. Tampering with the food chain only produces negative results, leading to the destruction of the species.

Every time a species becomes extinct, the chain is broken and many species, including humans, move closer to extinction.

8.1.4. Services provided by Biodiversity:

Biodiversity provides a number of natural services for human beings:

(a) Ecosystem services

- Protection of water resources
- Soils formation and protection
- Nutrient storage and recycling
- Pollution breakdown and absorption
- Contribution to climate stability
- Maintenance of ecosystems
- Recovery from unpredictable events

(b) Biological services

- Food
- Medicinal resources and pharmaceutical drugs
- Wood products
- Ornamental plants
- Breeding stocks
- Diversity in genes, species and ecosystems

(c) Social services

- Research, education and monitoring
- Recreation and tourism
- Cultural values

8.1.5 The Economics of Ecosystems and Biodiversity (TEEB)

The Economics of Ecosystems and Biodiversity (TEEB) was launched by Germany and the European Commission in 2007. It is a study led by Pavan Sukhdev.

It is an international initiative to draw attention to the global economic benefits of biodiversity.

Objective

Highlight the growing cost of biodiversity loss and ecosystem degradation and to draw together expertise from the fields of science, economics and policy to enable practical actions.

Aim

To assess, communicate and mainstream the urgency of actions through its five deliverables—

- Science and economic foundations, policy costs and costs of inaction,
- Policy opportunities for national and international policy-makers,
- Decision support for local administrators,
- Business risks, opportunities and metrics and
- Citizen and consumer ownership

The Ministry has launched the Economics of Ecosystems and Biodiversity TEEB-India Initiative (TII) to highlight the economic consequences of the loss of biological diversity and the associated decline in ecosystem services.

Do you know?

Wrinkles help elephants keep their body temperature down. Wrinkles increase the surface area, so that more skin becomes wet when the animal bathes. All the cracks and crevices trap moisture, which then takes much longer to evaporate. A wrinkly elephant keeps cooler for longer than it would with smooth skin.

8.1.6. Causes for Biodiversity Loss

Loss of biodiversity occurs when either a particular species is destroyed or the habitat essential for its survival is damaged. The latter is more common as habitat destruction is inevitable fallout of development.

The extinction of species takes place when they are exploited for economic gain or hunted as sport or for food. Extinction of species may also occur due to environmental reasons like ecological substitutions, biological factors and pathological causes which can be caused either by nature or man.

(a) Natural causes

- floods,
- earthquakes,
- landslides,
- rivalry among species,
- lack of pollination and diseases.

(b) Man-Made causes

- Habitat destruction
- Uncontrolled commercial exploitation
- Hunting & poaching
- Conversion of rich bio-diversity site for human settlement and industrial development
- Extension of agriculture
- Pollution
- Filling up of wetlands
- Destruction of coastal areas

8.1.7. Biodiversity conservation

Conservation of biological diversity leads to conservation of essential ecological diversity and preserve the continuity of food chains.

Do you know?

Eels are sometimes mistaken for Sea Snakes. Eels are part of the fish family and have gills for breathing. Sea snakes do not have gills but lungs instead and need to go to the surface for air.)

Modes of Conservation

(a) **Ex-situ conservation:** Conserving biodiversity outside the areas where they naturally occur is known as exsitu conservation.

- Here, animals are reared or plants are cultivated like zoological parks or botanical gardens. Reintroduction of an animal or plant into the habitat from where it has become extinct is another form of ex situ conservation.
- For example, the Gangetic gharial has been reintroduced in the rivers of Uttar Pradesh, Madhya Pradesh and Rajasthan where it had become extinct.
- Seed banks, botanical, horticultural and recreational gardens are important centres for ex-situ conservation.

(b) **In-situ conservation:** Conserving the animals and plants in their natural habitats is known as in-situ conservation. The established natural habitats are:

- National parks
- Sanctuaries
- Biosphere reserves and
- Reserved forests
- Protected forests

Constraints in biodiversity conservation

- Low priority for conservation of living natural resources.
- Exploitation of living natural resources for monetary gain.
- Values and knowledge about the species and ecosystem are inadequate.
- Unplanned urbanization and uncontrolled industrialization.

Do you know?

Itanagar Biological Park (zoo) is the world's first Hoolok Gibbon Breeding Center. The zoo covering an area of over 250 hectares, launched the Hoolock Gibbon Conservation Breeding Programme in 2007 is the first lesser apes' conservation centre in the country.

8.1.8. Botanical garden

Botanical garden refers to the scientifically planned collection of living trees, shrubs, herbs, climbers and other plants from various parts of the world.

Purpose of botanical gardens

1. To study the taxonomy as well as growth of plants.
2. To study the introduction and acclimatization process of exotic plants.
3. It acts as a germplasm collection.
4. It helps development of new hybrids.
5. It augments conserving rare and threatened species.

8.1.9. Zoo

Zoo is an establishment, whether stationary or mobile, where captive animals are kept for exhibition to the public and includes a circus and rescue centers but does not include an establishment of a licensed dealer in captive animals - CZA .

The initial purpose of zoos was entertainment, over the decades, zoos have got transformed into centres for wildlife conservation and environmental education.

Apart from saving individual animals, zoos have a role to play in species conservation too (through captive breeding).

Do you know?

Elephants' ears act as cooling devices. They can measure up to 2 square metres and they are equipped with an intricate web of blood vessels. When the animal flaps its ears, the blood temperature lowers by as much as 5°C.

8.2. THE RED DATA BOOK

Species judged as threatened are listed by various agencies as well as by some private organizations. The most cited of these lists is the Red Data Book.

It is a loose-leaf volume of information on the status of many kinds of species. This volume is continually updated and is issued by the International Union for Conservation of Nature (IUCN) located in Morges, Switzerland.

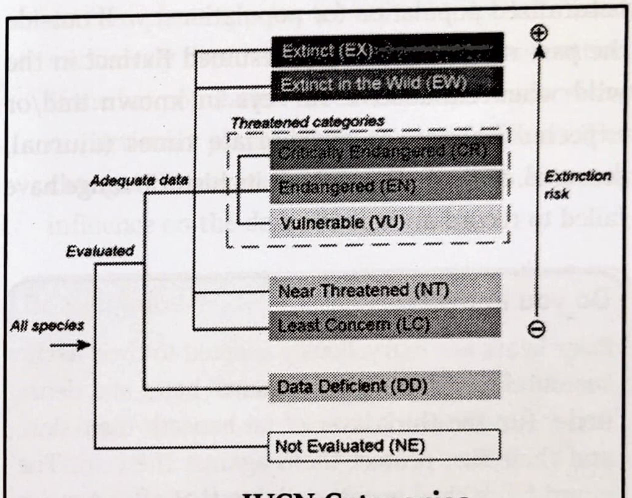
"Red" of course is symbolic of danger that the species both plants and animals presently experience throughout the globe.

The Red Data Book was first issued in 1966 by the IUCN's Special Survival Commission as a guide for formulation, preservation and management of species listed.

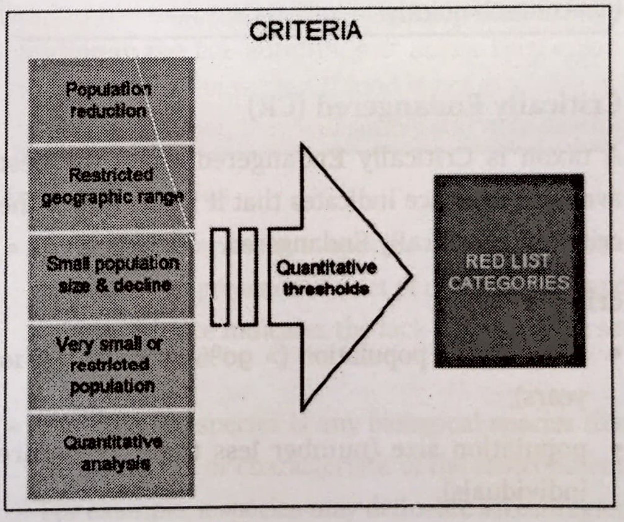
In this Book, information for endangered mammals and birds are more extensive than for other groups of animals and plants, coverage is also given to less prominent organisms facing extinction.

The pink pages in this publication include the critically endangered species. As the status of the species changes, new pages are sent to the subscribers.

Green pages are used for those species that were formerly endangered, but have now recovered to a point where they are no longer threatened. With passing time, the number of pink pages continue to increase. There are pitifully few green pages.



IUCN Categories


CRITERIA
Population reduction
Restricted geographic range
Small population size & decline
Very small or restricted population
Quantitative analysis
Quantitative thresholds
RED LIST CATEGORIES

8.2.1. IUCN Classification Of Conservation Priority

Extinct (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.

Extinct in the Wild (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.

Do you know?

Polar bears are marvellously adapted to their Arctic surroundings. Their glossy 'guard' hairs and dense under-fur, the thick layer of fat beneath their skin, and their size protect them against the cold. The guard hairs shed water easily, so that after a swim the polar bear can shake itself like a dog to dry and warm itself quickly.

Critically Endangered (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria for Critically Endangered.

criteria

- reduction in population (> 90% over the last 10 years),
- population size (number less than 50 mature individuals),
- quantitative analysis showing the probability of extinction in wild in at least 50% in their 10 years) and
- it is therefore considered to be facing an extremely high risk of extinction in the wild.

Endangered (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria for Endangered.

criteria

- reduction in population size (70% over the last 10 years),
- population size estimated to number fewer than 250 mature individuals,
- quantitative analysis showing the probability of extinction in wild in at least 20% within 20 years and
- it is therefore considered to be facing a very high risk of extinction in the wild.

Vulnerable (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria for Vulnerable i.e.

criteria

- reduction in population (> 50% over the last 10 years)
- population size estimated to number fewer than 10,000 mature individuals,
- probability of extinction in wild is at least 10% within 100 years, and
- it is therefore considered to be facing a high risk of extinction in the wild.

Near Threatened (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for

Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Least Concern (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

Data Deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking.

Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

Not Evaluated (NE)

A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Do you know?

Global 30 by 30 initiative is committed to conserving at least 30% of the planet's land and oceans by 2030

8.3. IMPORTANT SPECIES IN ECOSYSTEM

Keystone species

- Keystone species is a species whose addition to or loss from an ecosystem leads to major changes in abundance or occurrence of at least one other species. Certain species in an ecosystem is considered more important in determining the presence of many other species in that ecosystem.
- All top predators (Tiger, Lion, Crocodile, Elephant) are considered as keystone species because it regulates all other animals' population indirectly. Hence top predators are given much consideration in conservation.
- Key stone species deserves special attention from the conservation point of view. Conservation of keystone species encourages conservation of all other relevant species associated with this.
- If keystone species is lost, it will result in the degradation of whole ecosystem. For example certain plant species (ebony tree, Indian-laurel) exclusively depends upon bats for its pollination. If the bat population is reduced then regeneration of particular plants becomes more difficult. This changes the vegetation structure which adversely influence on the dependant animals.

Do you know?

polar bears have the ability to slow down their metabolism, after 7-10 days of not being able to feed, for whatever reason and at any time of year, until food becomes available again. This helps them adapt to the uncertainties of food availability in the Arctic. In comparison, black or brown bears can slow down their metabolism only in response to not feeding in the late autumn, just before they enter their dens for the winter. If food is not available in spring or summer, they will simply starve to death.

Indicator species

- Indicator species is a species whose presence indicates the presence of a set of other species and whose absence indicates the lack of that entire set of species.
- An indicator species is any biological species that defines a trait or characteristic of the environment. For example, a species may delineate an ecoregion

or indicate an environmental condition such as a disease outbreak, pollution, species competition or climate change. Indicator species can be among the most sensitive species in a region, and sometimes act as an early warning to monitoring biologists.

- Many indicator species of the ocean systems are fish, invertebrates, periphyton, macrophytes and specific species of ocean birds (like the Atlantic Puffin). Amphibian indicates chemicals, global warming and air pollution. Lichens are indicators of air quality and are sensitive to sulfur dioxide.

Foundation species

- Foundation species is a dominant primary producer in an ecosystem both in terms of abundance and influence. Example: kelp in kelp forests and corals in coral reefs.

◆ ◆ ◆ ◆ ◆ ◆

CHAPTER - 9

INDIAN BIODIVERSITY DIVERSE LANDSCAPE

India is a recognised as one of the mega-diverse countries, rich in biodiversity and associated traditional knowledge. With just 2.4% of the land area, India accounts for nearly 7% of the recorded species even while supporting almost 18% of human population.

In terms of species richness, India ranks seventh in mammals, ninth in birds and fifth in reptiles.

The varied Edaphic, Climatic and Topographic conditions have resulted in a wide range of ecosystems and habitats such as forests, grasslands, wetlands, coastal and marine ecosystems, and deserts in India with greater biodiversity.

9.1. INDIA REPRESENTS:

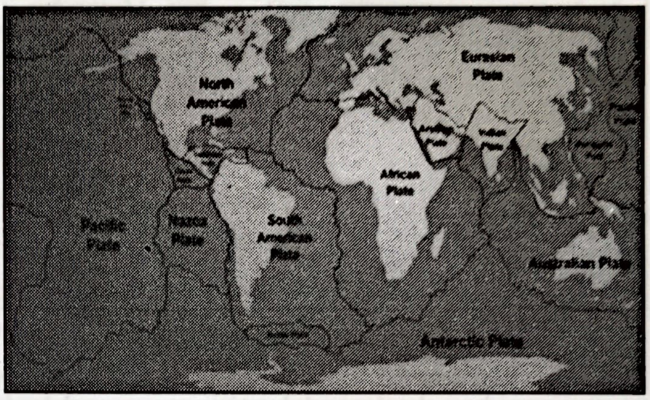
a) Two Realms
b) Five Biomes
c) Ten Bio-geographic Zones
d) Twenty five Bio-geographic provinces

a) Realms:

Biogeographic realms are large spatial regions within which ecosystems share a broadly similar biota. Realm is a continent or sub continent sized area with unifying features of geography and fauna & flora.

The Indian region is composed of two realms. They are:

1) the Himalayan region represented by Palearctic Realm and
2) the rest of the sub-continent represented by Malayan Realm



Realm

Eight terrestrial biogeographic realms are recognized.

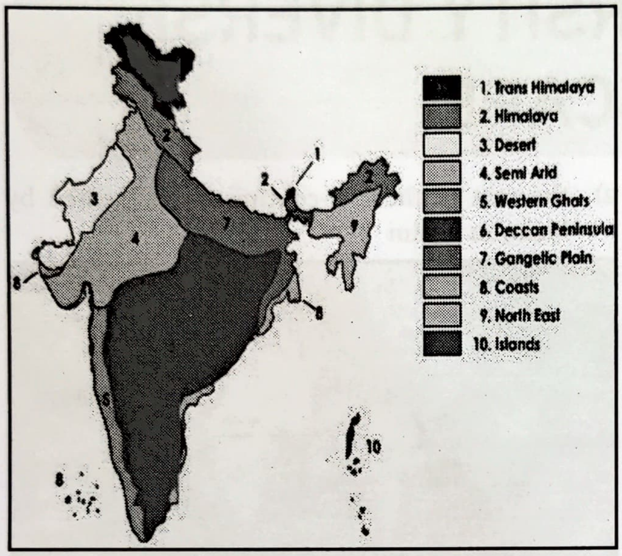
1. Nearctic realm
2. Palearctic realm
3. Africotropical realm
4. Indo-Malayan realm
5. Ocenaia realm
6. Australian realm
7. Antarctic realm
8. Neotropical realm

b) Biomes of India:

The term biome means the main groups of plants and animals living in areas of certain climate patterns. It includes the way in which animals, vegetation and soil interact together. The plants and animals living in the area are adapted to that environment. The five biomes of India are:

1) Tropical Humid Forests
2) Tropical Dry or Deciduous Forests (including Monsoon Forests)
3) Warm deserts and semi-deserts
4) Coniferous forests and
5) Alpine meadows.

c) Bio-geographic Zones:



Bio-geographic Zones India

Biogeography deals with the geographical distribution of plants and animals. There are 10 biogeographic zones which are distinguished clearly in India. They are as follows–

1) Trans-Himalayas: An extension of the Tibetan plateau, harboring high-altitude cold desert in Laddakh (J&K) and Lahaul Spiti (H.P) comprising 5.7 % of the country's landmass.
2) Himalayas: The entire mountain chain running from north-western to northeastern India, comprising a diverse range of biotic provinces and biomes, 7.2 % of the country's landmass.
3) Desert: The extremely arid area west of the Aravalli hill range, comprising both the salty desert of Gujarat and the sand desert of Rajasthan. 6.9% of the country's landmass.
4) Semi-arid: The zone between the desert and the Deccan plateau, including the Aravalli hill range. 15.6 % of the country's landmass.
5) Western ghats: The hill ranges and plains running along the western coastline, south of the Tapti river, covering an extremely diverse range of biotic provinces and biomes. 5.8% of the country's landmass.
6) Deccan peninsula: The largest of the zones, covering much of the southern and south central plateau with a predominantly deciduous vegetation. 4.3 % of the country's landmass.
7) Gangetic plain: Defined by the Ganges river system, these plains are relatively homogenous. 11% of the country's landmass.
8) North-east India: The plains and non-Himalayan hill ranges of northeastern India, with a wide variation of vegetation. 5.2% of the country's landmass.
9) Islands: The Andaman and Nicobar Islands in the Bay of Bengal, with a highly diverse set of biomes. 0.03% of the country's landmass.
10) Coasts: A large coastline distributed both to the west and east, with distinct differences between the two; Lakshadeep islands are included in this with the percent area being negligible.

Biogeography is divided into branches:

i. Phyto-geography (plant geography) deals with origin, distribution and environmental inter-relationships of plants.
ii. Zoogeography deals with the migration and distribution of animals.

d) Bio-geographic provinces.

Bio-geographic Province is a ecosystematic or biotic subdivision of realms. India is divided into 25 bio geographic zones.

Biogeographic classification of India was done by Rodgers and Panwar (1988), describing 10 biogeographic zones in India, further divided into 25 biogeographic provinces. The classification was done using various factors such as altitude, moisture, topography, rainfall, etc. Biogeographic zones were used as a basis for planning wildlife protected areas in India.

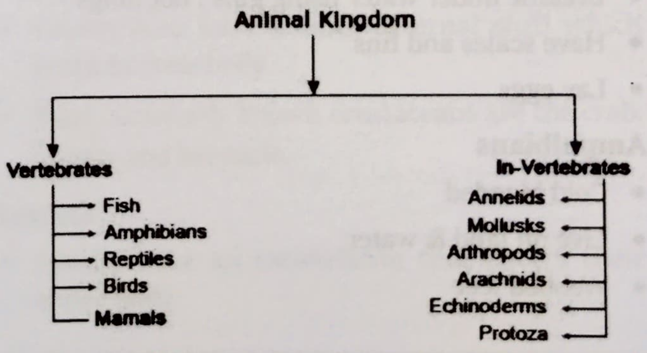
9.1.1. Biogeographic zones and Biogeographic Provinces of India

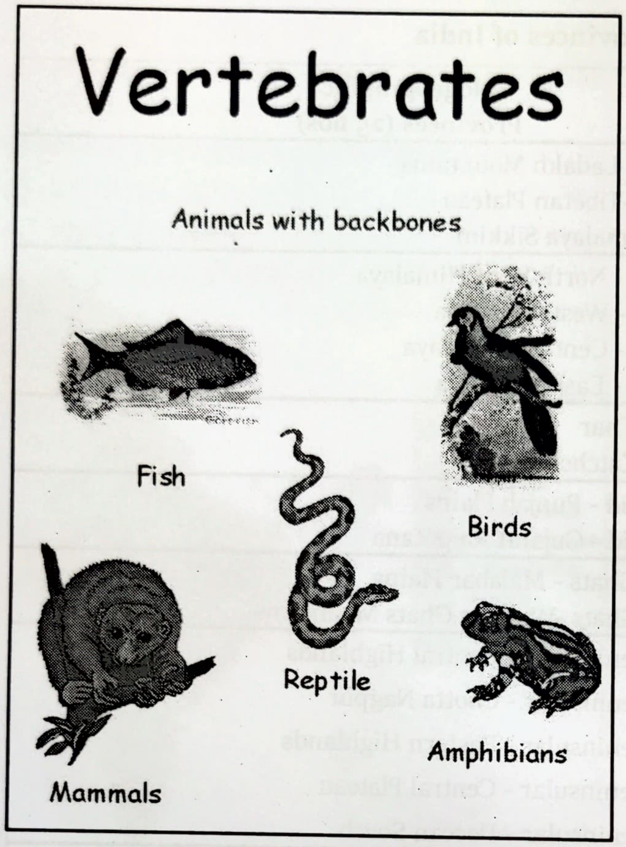
S.No.	Biogeographic Zones (10 nos)	Biogeographic Provinces (25 nos)
1.	Trans Himalaya	1A: Himalaya -Ladakh Mountains 1B: Himalaya -Tibetan Plateau 1C: Trans - Himalaya Sikkim
2.	The Himalaya	2A: Himalaya - North West Himalaya 2B: Himalaya - West Himalaya 2C: Himalaya - Central Himalaya 2D: Himalaya - East Himalaya
3.	The Indian Desert	3A: Desert – Thar 3B: Desert – Katchchh
4.	The Semi Arid	4A: Semi - Arid - Punjab Plains 4B: Semi - Arid - Gujarat Rajputana
5.	The Western Ghats	5A: Western Ghats - Malabar Plains 5B: Western Ghats -Western Ghats Mountains
6.	The Deccan Peninsula	6A: Deccan Peninsular - Central Highlands 6B: Deccan Peninsular - Chotta Nagpur 6C: Deccan Peninsular - Eastern Highlands 6D: Deccan Peninsular - Central Plateau 6E: Deccan Peninsular - Deccan South
7.	The Gangetic Plains	7A: Gangetic Plain - Upper Gangetic Plains 7B: Gangetic Plain - Lower Gangetic Plains
8.	The Coasts	8A: Coasts - West Coast 8B: Coasts - East Coast 8C: Coasts – Lakshdweep
9.	Northeast India	9A: North - East - Brahamputra Valley 9B: North - East – North East Hills
9.	Islands	10A: Islands – Andamans 10B: Islands – Nicobars

9.2 FAUNA

9.2.1. Vertebrates

Vertebrates are animals with backbones and spinal columns. Vertebrates are the most advanced organisms on Earth. Although vertebrates represent only a very small percentage of all animals, their size and mobility often allow them to dominate their environment.





Do you know?

Dolphins, Porpoises and whales are called cetaceans. A cetacean is a creature belonging to a group of water living mammals that have no hind limbs and a blowhole for breathing. They are not fish!

Fishes

- Cold blooded
- Live in water
- Breathe under water using gills , not lungs
- Have scales and fins
- Lay eggs

Amphibians

- Cold blooded
- Live on land & water
- Webbed feet
- Breathe with lungs and gills
- Moist smooth skin
- Four legs (sometimes none)
- Lay eggs

Reptiles

- Cold blooded
- Have scales
- Have dry skin
- Usually lay eggs
- Ear holes instead of ears
- 4 legs or no legs

Aves

- Warm blooded
- Have feathers and wings
- Lay eggs
- Have 2 legs
- Ear holes instead of ears

Mammals

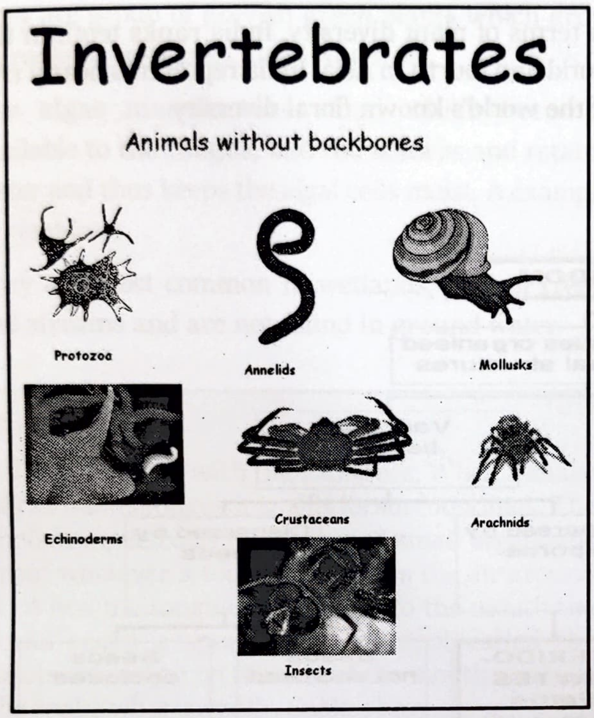
- Warm blooded
- Have hair or fur
- Give birth to live young ones
- Mammal mother nurse their young one with milk
- Breathe with lungs
- Mammals live on land have 4 legs (or 2 legs & 2 arms), and ears that stick out.

Do you know?

Elephants' ears act as cooling devices. They can measure up to 2 square metres and they are equipped with an intricate web of blood vessels. When the animal flaps its ears, the blood temperature lowers by as much as 5°C.

9.2.2. Invertebrates

Invertebrates do not have backbones. More than 98% animal species in the world are invertebrates. Invertebrates don't have an internal skeleton made of bone. Many invertebrates have a fluid-filled, hydrostatic skeleton, like the jelly fish or worm. Others have a hard outer shell, like insects and crustaceans.



Do you know?

Pythons are constrictors, which mean that they will 'squeeze' the life out of their prey. They coil themselves around their prey and with each breathe the creature takes the snake will squeeze a little tighter until they stop breathing completely. Once the heart stops the prey is swallowed whole. The entire animal is digested in the snake's stomach except for fur or feathers.

Annelids

- Annelids have bodies that are divided into segments.
- They have very well-developed internal organs.
- Found almost anywhere in the world.
- They don't have any limbs.
- E.g: earthworms, leeches, roundworms, etc.

Mollusks

- Most mollusks have a soft, skin-like organ covered with a hard outside shell.
- Some mollusks live on land, such as the snail and slug.
- Other mollusks live in water, such as the oyster, mussel, clam, squid and octopus.

Echinoderms

- Echinoderms are marine animals that live in the ocean.
- Most echinoderms have arms or spines that radiate from the center of their body.
- Common echinoderms include the sea star, sea urchin, sand dollar and sea cucumber.

Protozoa

- Protozoa are simple, single-celled animals.
- They are the smallest of all animals.
- Most protozoa are microscopic.
- They do breathe, move and reproduce like multicelled animals.
- E.g: amoebas, Flagellates,etc.

Arthropods

- Arthropods have limbs with joints that allow them to move.
- They also have an exoskeleton, which is a hard, external skeleton.
- Arthropods include the crustaceans and insects, arachnids.

Crustaceans

- live mostly in the ocean or other waters.
- Crustaceans have a hard, external shell which protects their body
- Most commonly known crustaceans are the crab, lobster and barnacle.

Insects

- Insects have an exoskeleton that covers their entire body.

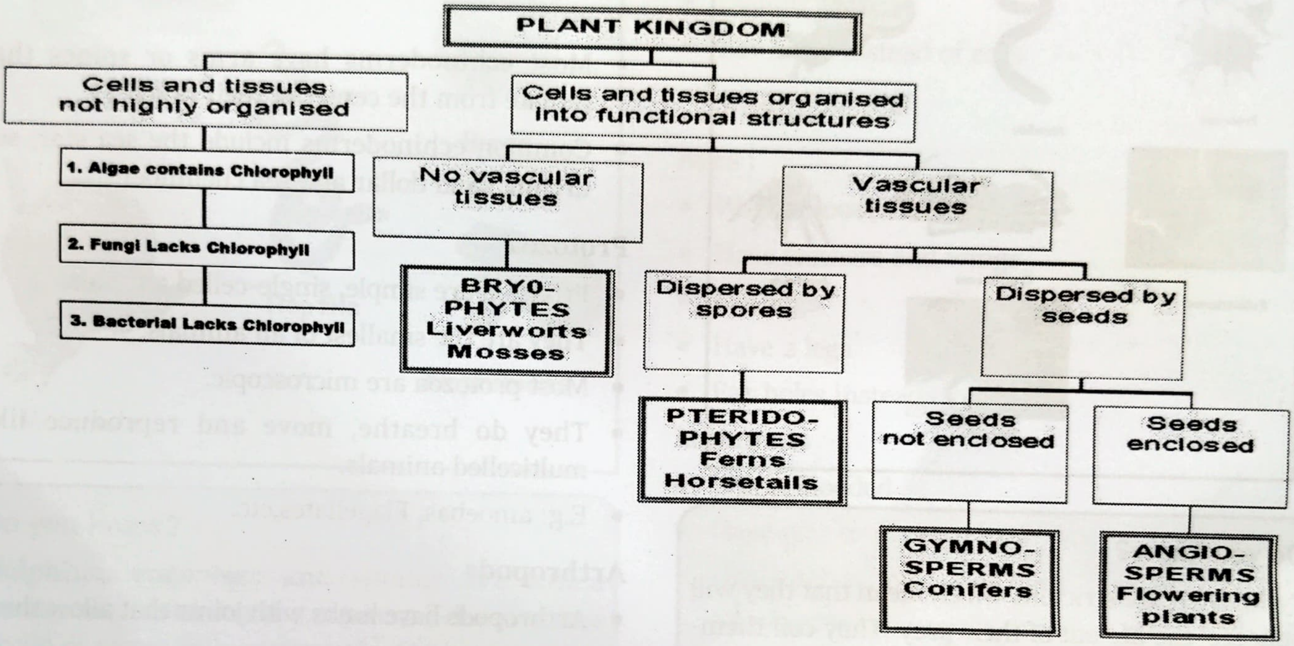
- An insect's consists of 3 body parts and 6 legs and a antennae
- E.g: beetle, butterfly, moth, dragonfly, bee, wasp and praying mantis.

Arachnids

- Common arachnids are spiders, scorpions, ticks and mites.
- Arachnids do not have antennae.
- Arachnids have 2 body parts and 4 pairs of legs.

9.3. FLORAL DIVERSITY

In terms of plant diversity, India ranks tenth in the world and fourth in Asia. India represents nearly 11% of the world's known floral diversity.


PLANT KINGDOM
Cells and tissues not highly organised
Cells and tissues organised into functional structures
1. Algae contains Chlorophyll
2. Fungi Lacks Chlorophyll
3. Bacterial Lacks Chlorophyll
No vascular tissues
Vascular tissues
BRYO-PHYTES Liverworts Mosses
Dispersed by spores
Dispersed by seeds
PTERIDO-PHYTES Ferns Horsetails
Seeds not enclosed
Seeds enclosed
GYMNO-SPERMS Conifers
ANGIO-SPERMS Flowering plants

9.3.1. Important floral groups found in India are described below:

1. Algae

The green non differentiated plants (non - differentiated into organs like root, stem and leaf.) possessing chlorophyll are known as Algae. They usually grow in water or in moist situations.

The fresh-water algae are generally green or blue-green in colour, whereas the marine ones are red or brown. These are autotrophic plants, as they can manufacture their own food.

2. Fungi:

Non-green non differentiated plants characterised by total absence of chlorophyll are called Fungi. They grow either on dead, rotten organic matters as saprophytes or live as parasites on other living bodies, which are referred to as hosts.

Moulds and mushrooms are the familiar examples of saprophytic fungi. The maximum diversity of fungi is in the Western Ghats followed by the eastern Himalaya and the western Himalaya.

3. Bacteria

Non-chlorophyllous micro-organisms which lead saprophytic or parasitic existence. Many of them are pathogenic; Saprophytic bacteria are rather beneficial. They are soil borne and many of them are used in industries.

4. Lichens

A lichen is a peculiar combination of an alga and a fungus–the two live deriving mutual benefit.

They are group of greyish green plants which grow on rocks, tree-trunks, dead wood, etc.

The algae manufactures food which becomes available to the fungus, and the absorbs and retains water and thus keeps the algal cells moist. A example of symbiosis.

They are most common in wetlands, rare in rivers and streams and are not found in ground water.

Do you know?

All snakes smell with their tongues. When a snake sticks out its tongue it smells its surroundings. The moist tongue collects scents and small organisms from whatever it touches and from the air around it. When the tongue goes back into the mouth the forks touch a special sensory spot called the Jacobson's organ on the roof of the mouth and tells the snake what it smells. Snakes have a small notch in their lips that they can stick their tongues through so they don't need to open their mouths. Some snakes can smell with their noses.

5. Bryophytes

The plant body is differentiated into a small stem and simple leaves, but true roots are absent.

They usually grow in moist places. E.g. Liverworts, mosses

They are the second largest group of green plants in India distributed largely in Eastern Himalaya, North-eastern India, Western Himalaya and the Western Ghats.

Mosses constitute the major component of Indian bryoflora followed by liverworts and hornworts.

6. Pteridophytes

The pteridophytes have well-differentiated plant bodies, consisting of roots, stems and leaves. Moreover, they possess vascular bundles.

Most of them are terrestrial plants flourishing well in moist and shady places, and some of them are aquatic.

This group includes the vascular cryptogams like club-mosses, horse-tails and ferns which are universally distributed all over the world.

The north-eastern region (including Eastern Himalaya) is rich in pteridophytic diversity, followed by south India (including Eastern and Western Ghats) and north India (including Western Himalaya).

Do you know?

Penguins are warm blooded, Just like whales, penguins have a layer of fat under their skin called "blubber". Overtop of this they are covered with fluffy "down" feathers and overtop of those they have their outer feathers which overlap to seal in warmth. Penguins rub oil from a gland onto their feathers to help make them waterproof and wind proof.

7. Gymnosperms

Gymnosperms (gymnos=naked, sperma=seed) are the naked-seeded plants.

They have very simple flowers without accessory whorls and stamens and carpels remain aggregated in cones.

Ovules are present on the surface of the carpels and are directly pollinated by the pollen grains.

There is nothing like ovary, style and stigma, and naturally there is no fruit.

e.g. Cycas, Pinus, Gnetum.

Pine is the largest family. Gnetum and Cycas are mostly confined to North Eastern region, Eastern and Western Ghats, and Andaman & Nicobar Islands.

8. Angiosperms:

Angiosperms (angeion=a case) are the closed-seeded plants.

These are the most highly developed plants which bear flowers having conspicuous accessory and essential whorls. Carpels have the ovary, style and stigma.

With the stimulus of fertilization the ovary usually develops into the fruit and the ovules into seeds. Thus the seeds remain within the fruits.

India has more than 7% of the world's known flowering plants.

9.3.2. Floral endemism - order

1) peninsular India including western and Eastern Ghats (about 2,600 species),
2) Eastern Himalaya and north-eastern region (about 2,500 species),
3) north-western Himalaya (about 800 species) and
4) Andaman & Nicobar Islands (about 250 species).

Do you know?

Bats are social animals. They hang UPSIDE DOWN when they sleep. They feed at night (they are "nocturnal") and spend the day sleeping in caves or in tree tops. They are the second largest group of mammals after rodents.

9.3.3. Crop genetic diversity

Agriculture remains one of the dominant drivers and mainstay of economic growth in India. The large mosaic of distinct agro-ecosystems, characterized by variations in edaphic, climatic and geographic features, has contributed to diverse cropping patterns and systems across the country.

India stands seventh in the world in terms of contribution of species to agriculture and animal husbandry.

The national gene bank at National Bureau Of Plant Genetic Resources (NBPGR), Delhi is primarily responsible for conservation of unique accessions on long-term basis, as base collections for posterity, predominantly in the form of seeds.

9.3.4. Livestock genetic diversity

India has vast resources of livestock and poultry, which play a vital role in rural livelihood security. In terms of population, India ranks first in buffaloes, second in cattle and goats, third in sheep, fourth in ducks, fifth in chicken and sixth in camels in the world.

The genetic resources of farm animals in India are represented by a broad spectrum of native breeds of cattle, buffaloes, goats, sheep, swine, equines, camel and poultry.

Over the years, animal husbandry has intensified in India with widespread introduction of exotic breeds. This has led to the reduction in total genetic variability and population size of many local breeds. The majority (85%) of the domestic livestock in India is reared under low input production systems.

Do you know?

Reptiles are cold-blooded animals that raise their body temperature by lying in the sun or lower it by crawling into the shade. Their body temperature changes to the temperature of its surroundings.

9.4. WILDLIFE OF INDIA

9.4.1. Himalayan mountain system

The west Himalayas have low rainfall, heavy snowfall (temperate conditions), whereas in east Himalayas, there is heavy rainfall, snowfall only at very high altitudes, where as at lower altitudes conditions are similar to the tropical rain forests. Flora and fauna of both Himalayas differ.

(1) Himalayan foothills

Flora: Natural monsoon evergreen and semi-evergreen forests; dominant species are sal, silk-cotton trees, giant bamboos; tall grassy meadow with savannahs in tarai.

(2) Western Himalayas (High altitude region)

Flora: Natural monsoon evergreen and semi-evergreen forests; rhododendrons; dwarf hill bamboo and birch forests mixed with alpine pastures.

(3) Eastern Himalayas.

Flora: Oaks, magnolias, laurels and birches covered with moss and ferns; coniferous forests of pine, fir, yew and junipers with undergrowth of scrubby rhododendrons and dwarf bamboos; lichens, moses, orchids, and other epiphytes dominant (due to high humidity and high rainfall).

Do you know?

Polar bears are very well adapted to swimming, with a water-repellent coat and partially webbed feet.

9.4.2. Peninsular - Indian sub-region

It has two zones.

(i) peninsular India and its extension into the drainage basin of the Ganges river system, and

(ii) desert region of Rajasthan-the Thar of Indian desert region.

(1) Peninsular India

It is home to tropical moist deciduous to tropical dry deciduous and scrub vegetation depending upon the variation in rainfall and humidity.

Flora: Sal in north and east extensions (higher rainfall) and teak in southern plateau are dominant trees. West Ghats have evergreen vegetation (flora and fauna similar to evergreen rainforests of north eastern of India. In dry areas of Rajasthan and Aravalli hills, trees are scattered and thorny scrub species predominate. The forests give way to more open savannah habit.

(2) Indian desert

Thar desert of Rajasthan has unique flora and fauna.

Flora: Throny trees with reduced leaves; cacti, other succulents are the main plants.

9.4.3. Tropical rain forest region

Distributed in areas of western ghats and north east India.

Flora: Extensive grass lands interspersed with densely forested gorges of evergreen vegetation known as sholas occur in the Nilgiris (an offshoot of Western ghats). Sholas also occur in Aanaimalai and Palani hills. The rain forests of the Western ghats have dense and lofty trees with much species diversity. Mosses, ferns, epiphytes, orchids, lianas and vines, herbs, shrubs make diverse habitat. Ebony trees predominate in these forests. A variety of tropical orchids are found. Stratification in rain forests is very distinct-three horizontal layers are distinguished.

9.4.4. Andaman and Nicobar Islands

Flora: These are home for tropical rain forests. Giant Dipterocarpus, Terminalia and Lagerstroemia are dominant. Mangroves are also distributed in the coastal areas.

9.4.5. Mangrove swamps of Sunderbans

Sunderbans are delta of the Ganges where both the Brahmaputra and Ganges join and drain into the Bay of Bengal.

Flora: The lower tidal zones are pioneer trees like Sonneratia and avicennia. Above this zone there are rhizophora, bruguiria and excaecaria-cereops forest (covering nearly 70% of mangrove forest). Above this level there are supporting forest of phoneix in association with excaecaria. There are heriteria forest in the highest portion with thick undergrowth of phoneix and neepa plams.

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CHAPTER - 10

INDIAN FOREST

10.1. INDIAN FOREST TYPES

India has a diverse range of forests from the rainforest of Kerala in the south to the alpine pastures of Ladakh in the north, from the deserts of Rajasthan in the west to the evergreen forests in the north-east. Climate, soil type, topography, and elevation are the main factors that determine the type of forest. Forests varied according to their nature and composition, the type of climate in which they thrive, and its relationship with the surrounding environment.

Champion and Seth Classification of Forest

Forest types in India are classified by Champion and Seth into sixteen types.

10.1.1. Tropical Wet evergreen forests

Wet evergreen forests are found along the Western Ghats, the Nicobar and Andaman Islands and all along the north-eastern region. It is characterized by tall, straight evergreen trees. The more common trees that are found here are the jackfruit, betel nut palm, jamun, mango, and hollock. The trees in this forest form a tier pattern: shrubs cover the layer closer to the ground, followed by the short structured trees and then the tall variety. Beautiful fern of various colours and different varieties of orchids grow on the trunks of the trees.

10.1.2. Tropical Semi-evergreen forests

Semi-evergreen forests are found in the Western Ghats, Andaman and Nicobar Islands, and the Eastern Himalayas. Such forests have a mixture of the wet evergreen trees and the moist deciduous trees. The forest is dense and is filled with a large variety of trees of both types.

10.1.3. Tropical Moist deciduous forests

Moist deciduous forests are found throughout India except in the western and the north-western regions. The trees are tall, have broad trunks, branching trunks and roots to hold them firmly to the ground. Some of the taller trees shed their leaves in the dry season. There is a layer of shorter trees and evergreen shrubs in the undergrowth. These forests are dominated by sal and teak, along with mango, bamboo, and rosewood.

10.1.4. Littoral and swamp

Littoral and swamp forests are found along the Andaman and Nicobar Islands and the delta area of the Ganga and the Brahmaputra. They have roots that consist of soft tissue so that the plant can breathe in the water.

10.1.5. Tropical Dry deciduous forest

Dry deciduous forests are found throughout the northern part of the country except in the North-East. It is also found in Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka, and Tamil Nadu. The canopy of the trees does not normally exceed 25 metres. The common trees are the sal, a variety of acacia, and bamboo.

10.1.6. Tropical Thorn forests

This type is found in areas with black soil: North, West, Central, and South India. The trees do not grow beyond 10 metres. Spurge, caper, and cactus are typical of this region.

10.1.7. Tropical Dry evergreen forest

Dry evergreens are found along Tamil Nadu, Andhra Pradesh and Karnataka coast. It is mainly hard-leaved evergreen trees with fragrant flowers, along with a few deciduous trees.

10.1.8. Sub tropical Broad-leaved forests

Broad-leaved forests are found in the Eastern Himalayas and the Western Ghats, along the Silent Valley. There is a marked difference in the form of vegetation in the two areas. In the Silent Valley, the poonspar, cinnamon, rhododendron, and fragrant grass are predominant. In the Eastern Himalayas, the flora has been badly affected by the shifting cultivation and forest fires. These wet forests consist mainly of evergreen trees with a sprinkling of deciduous here and there. There are oak, alder, chestnut, birch, and cherry trees. There are a large variety of orchids, bamboo and creepers.

10.1.9. Sub tropical Pine forests

Pine forests are found in the steep dry slopes of the Shivalik Hills, Western and Central Himalayas, Khasi, Naga, and Manipur Hills. The trees predominantly found in these areas are the chir, oak, rhododendron, and pine as well as sal, amla, and laburnum are found in the lower regions.

10.1.10. Sub tropical Dry evergreen forests

Dry evergreen forests normally have a prolonged hot and dry season and a cold winter. It generally has evergreen trees with shining leaves that have a varnished look. These forests are found in the Shivalik Hills and foothills of the Himalayas up to a height of 1000 metres.

10.1.11. Montane Wet temperate forests

In the North, Montane wet temperate forests are found in the region to the east of Nepal into Arunachal Pradesh, receiving a minimum rainfall of 2000 mm. In the North, there are three layers of forests: the higher layer has mainly coniferous, the middle layer has deciduous trees such as the oak and the lowest layer is covered by rhododendron and champa.

In the South, it is found in parts of the Niligiri Hills, the higher reaches of Kerala. The forests in the northern region are denser than in the South. Rhododendrons and a variety of ground flora can be found here.

10.1.12. Himalayan Moist temperate Forest

This type spreads from the Western Himalayas to the Eastern Himalayas. The trees found in the western section are broad-leaved oak, brown oak, walnut, rhododendron, etc. In the Eastern Himalayas, the rainfall is much heavier and therefore the vegetation is also more lush and dense. There are a large variety of broad-leaved trees, ferns, and bamboo. Coniferous trees are also found here, some of the varieties being different from the ones found in the South.

10.1.13. Himalayan Dry temperate Forest

This type is found in Lahul, Kinnaur, Sikkim, and other parts of the Himalayas. There are predominantly coniferous trees, along with broad-leaved trees such as the oak, maple, and ash. At higher elevation, fir, juniper, deodar, and chilgoza are found.

10.1.14. Sub alpine forest

Sub alpine forests extend from Kashmir to Arunachal Pradesh between 2900 to 3500 metres. In the Western Himalayas, the vegetation consists mainly of juniper, rhododendron, willow, and black currant. In the eastern parts, red fir, black juniper, birch, and larch are the common trees. Due to heavy rainfall and high humidity the timberline in this part is higher than that in the West. Rhododendron of many species covers the hills in these parts.

10.1.15. Moist Alpine scrub

Moist alpines are found all along the Himalayas and on the higher hills near the Myanmar border. It has a low scrub, dense evergreen forest, consisting mainly of rhododendron and birch. Mosses and ferns cover the ground in patches. This region receives heavy snowfall.

10.1.16. Dry alpine scrub

Dry alpines are found from about 3000 metres to about 4900 metres. Dwarf plants predominate, mainly the black juniper, the drooping juniper, honeysuckle, and willow.

10.2 INDIAN STATE OF FOREST REPORT, 2021

- State of Forests Report is published by the Forest Survey of India (FSI) on a biennial basis since 1987.
- The India State of Forest Report 2021 is the 17th report in the series. It is based on interpretation of LISS III sensor data of indigenous Resourcesat – II satellite. The satellite data interpretation is followed by extensive and rigorous ground truthing.
- The total forest and tree cover is 24.39 percent of the total geographical area. Forest and Tree Cover of the country has increased by 2,261 sq km as compared to the assessment of 2019. The very dense forest (VDF) has increased by 500 sq km as compared to the last assessment. VDF absorbs maximum carbon dioxide from the atmosphere.
- Madhya Pradesh has the largest forest cover in the country, followed by Arunachal Pradesh and Chhattisgarh.
- In terms of forest cover as percentage of total geographical area, the top five States are Mizoram (84.53%), Arunachal Pradesh (79.33%), Meghalaya (76.00%), Manipur (74.34%) and Nagaland (73.90%).
- 17 states/UT's have above 33 percent of the geographical area under forest cover. Out of these states and UT's, five states/UTs namely Lakshadweep, Mizoram, Andaman & Nicobar Islands, Arunachal Pradesh and Meghalaya have more than 75 percent forest cover while 12 states/ UTs namely Manipur, Nagaland, Tripura, Goa, Kerala, Sikkim, Uttarakhand, Chhattisgarh, Dadra & Nagar Haveli and Daman & Diu, Assam, Odisha, have forest cover between 33 percent to 75 percent.
- Total mangrove cover in the country is 4,992 sq km. An increase of 17 sq Km in mangrove cover has been observed as compared to the previous assessment of 2019. Top three states showing mangrove cover increase are Odisha (8 sq km) followed by Maharashtra (4 sq km) and Karnataka (3 sq km).
- Total carbon stock in country's forest is estimated to be 7,204 million tonnes and there an increase of 79.4 million tonnes in the carbon stock of country as compared to the last assessment of 2019. The annual increase in the carbon stock is 39.7 million tonnes.
- ISFR 2021 has some new features. For the first time forest cover in tiger reserves, tiger corridors and the Gir forest which houses the Asiatic lion has been assessed. Between 2011-2021 forest cover in tiger corridors has increased by 37.15 sq km (0.32%) and tiger reserves has decreased by 22.6 sq km (0.04%).
- Forest cover has increased in 20 tiger reserves in these 10 years, and decreased in 32. Buxa, Anamalai and Indravati reserves have shown an increase in forest cover while the highest losses have been found in Kawal, Bhadra and the Sunderbans reserves. Pakke Tiger Reserve in Arunachal Pradesh has the highest forest cover (nearly 97%).
- By 2030, 45% of forests will experience the climate change impact. Except Assam, Meghalaya, Tripura and Nagaland all states will be highly vulnerable climate hot spots while Ladakh (forest cover 0.1-0.2%) is likely to be the most affected.
- India's forests are already showing shifting trends of vegetation types, Sikkim has shown a shift in its vegetation pattern for 124 endemic species.
- Forest Fire Hotspots detected were 1.2 lakh in 2019-20 and 3.4 lakh in 2020-21. The highest numbers of fires were detected in Odisha, Madhya Pradesh and Chhattisgarh.

10.3. FOREST ACTS AND POLICIES

10.3.1. National Forest Policy 1988

- The principal aim of National Forest Policy, 1988 is to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which are vital for sustenance of all life forms, human, animal and plant.

Objectives

- Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country.
- Checking soil erosion and denudation in the catchments areas of rivers, lakes, reservoirs in the "interest of soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs.
- Checking the extension of sand-dunes in the desert areas of Rajasthan and along the coastal tracts.
- Increasing substantially the forest/tree cover in the country through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
- Increasing the productivity of forests to meet essential national needs.
- Encouraging efficient utilisation of forest produce and maximising substitution of wood.

The major achievements of National Forest Policy, 1988,

- Increase in the forest and tree cover.
- Involvement of local communities in the protection, conservation and management of forests through Joint Forest Management Programme.
- Meeting the requirement of fuel wood, fodder minor forest produce and small timber of the rural and tribal populations.
- Conservation of Biological Diversity and Genetic Resources of the country through ex-situ and in-situ conservation measures.
- Significant contribution in maintenance of environment and ecological stability in the country.

10.3.2. The Scheduled Tribes And Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

- Forest Rights Act, 2006 provides for the restitution of deprived forest rights across India, including both individual rights to cultivated land in forestland and community rights over common property resources.
- The Act is significant as it provides scope and historic opportunity of integrating conservation and livelihood rights of the people.

FRA is a potential tool

I. To empower and strengthen the local self governance

II. To address the livelihood security of the people

III. To address the issues of Conservation and management of the Natural Resources and conservation governance of India.

- For the first time Forest Rights Act recognises and secures

i. Community Rights in addition to their individual rights

ii. Right to protect, regenerate or conserve or manage any community forest resource which the communities have been traditionally protecting and conserving for sustainable use.

iii. Right to intellectual property and traditional knowledge related to biodiversity and cultural diversity

iv. Rights of displaced communities & Rights over developmental activities

Salient Features

- Nodal Agency for the implementation is MoTA.
- This Act is applicable for Tribal and Other Traditional Forest Dwelling Communities.
- The Act provides for recognition of forest rights of other traditional forest dwellers provided they have for at least three generations prior to 13.12.2005 primarily resided in and have depended on the forest or forest land for bonafide livelihood needs. A "generation" for this purpose would mean a period comprising of 25 years.
- The maximum limit of the recognizing rights on forest land is 4 ha.
- National Parks and Sanctuaries have been included along with Reserve Forest, Protected Forests for the recognition of Rights.
- The Act recognizes the right of ownership access to collect, use, and dispose of minor forest produce which has been traditionally collected within or outside village boundaries.
- The Act has defined the term "minor forest produce" to include all non-timber forest produce of plant origin, including bamboo, brush wood, stumps, cane, tussar, cocoons, honey, wax, lac, tendu or kendu leaves, medicinal plants and herbs, roots, tubers and the like.
- The Act provides for the forest right relating to Government providing for diversion of forest land for the purpose of schools, hospitals, anganwadis, drinking water supply and water pipelines, roads, electric and telecommunication lines, etc.
- The rights conferred under the Act shall be heritable but not alienable or transferable and shall be registered jointly in the name of both the spouses in the case of married persons and in the name of the single head, in the case of a household headed by a single person and in the absence of a direct heir, the heritable right shall pass on to the next of kin
- The Act provides that no member of a forest dwelling Scheduled Tribe or other traditional forest dwellers shall be evicted or removed from forest land under his occupation till the recognition and verification procedure is completed.
- As per the Act, the Gram Sabha has been designated as the competent authority for initiating the process of determining the nature and extent of individual or community forest rights or both that may be given to the forest dwelling Scheduled Tribes and other traditional forest dwellers.

10.3.3. Forest Conservation Rules 2022:

As per the provisions of Forest (Conservation) Act, 1980, the Approval of the Central Government under the Forest (Conservation), Act 1980 is a prior approval of the Central Government which does not directly lead to non-forestry use or breaking of forest land. Forest (Conservation) Rules, 2022 have been promulgated solely to implement the provisions of the Forest (Conservation) Act, 1980.

Salient features:

1. Committee Formation: These rules establish various committees, including an Advisory Committee, regional empowered committees at integrated regional offices, and screening committees at the State/Union Territory (UT) government level.
2. Compensatory Afforestation: Applicants seeking to divert forest land in hilly or heavily forested states can now undertake compensatory afforestation in states/UTs with less than 20% forest cover.
3. Private Plantations: The rules allow private entities to cultivate plantations and sell them as land to companies aiming to meet compensatory afforestation targets.
4. Simplified Approval Process: Previously, state bodies forwarded documents to the Forest Advisory Committee (FAC) and included information on the settlement of forest rights for local communities. The updated rules streamline the process, with

FAC approval leading to state authorities collecting compensatory funds and land for final approval.

5. Gram Sabha Consent Not Required: Unlike before, the new rules state that projects approved by the FAC won't require written consent from the gram sabha or village governing body.
6. Construction in Forests: The rules permit the construction of structures for legitimate purposes, such as forest protection measures and residential units (up to 250 sq meters as a one-time relaxation).

10.4. GOVERNMENT MEASURES

10.4.1. National Afforestation and Eco-Development Board

- The Ministry of Environment and Forests constituted the National Afforestation and Eco-development Board (NAEB) in August 1992. National Afforestation and Eco-development Board has evolved specific schemes for promoting afforestation and management strategies, which help the states in developing specific afforestation and management strategies and eco-development packages for augmenting biomass production through a participatory planning process of Joint Forest Management and microplanning

National Afforestation Programme

- A National Afforestation Programme (NAfP) was launched in 2002, which involves plantation in degraded forests of the country.
- NAfP is a flagship programme of National Afforestation and Eco-development Board (NAEB) and provides physical and capacity building support to the Forest Development Agencies (FDAs), which are the implementing agencies.

10.4.2 Compensatory Afforestation Fund Management and Planning Authority (Campa)

- While according prior approval under the Forest (Conservation) Act, 1980 for diversion of forest land for non-forest purpose, Central Government stipulates conditions that amounts shall be realised from the user agencies to undertake compensatory afforestation and such other activities related to conservation and development of forests, to mitigate impact of diversion of forest land.
- In April 2004, the central government, under the orders of the Supreme Court, constituted the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) for the management of money towards compensatory afforestation, and other money recoverable, in compliance of the conditions stipulated by the central government and in accordance with the Forest (Conservation) Act,
- CAMPA as envisaged by the Supreme Court of India vide its order dated 29/30.10.2002, could not become operational due to non-passing of Compensatory Afforestation Fund Bill 2008 in the Parliament. But it got lapsed.
- In compliance of Orders passed by the Hon'ble Supreme Court these amounts are deposited in the State-wise accounts operated by an Ad-hoc Authority consisting of two officials of the Ministry of Environment, Forests and Climate Change one representative of the Comptroller and Auditor General and one representative of the Chairperson of the Central Empowered Committee.
- In the absence of permanent institutional mechanism more than Rs.40,000 crores have accumulated with the said ad-hoc Body.
- In order to provide for the establishment of funds under the public accounts of India and the public accounts of each State and crediting thereto the monies received from the user agencies towards compensatory afforestation, additional compensatory afforestation, penal compensatory afforestation, net present value and all other amounts recovered from such agencies under the Forest (Conservation) Act, 1980 Central Government introduced the Compensatory Afforestation Fund Bill, 2015 in the LokSabha on 8th May 2015. The Bill also provides for constitution of an authority at national level and

at each of the State and Union territory Administration for administration of the funds and to utilise the monies so collected for undertaking artificial regeneration (plantations), assisted natural regeneration, protection of forests, forest related infrastructure development, Green India Programme, wildlife protection and other related activities and for matters connected therewith or incidental thereto.

Salient features

- These Funds will receive payments for: (i) compensatory afforestation, (ii) net present value of forest (NPV), and (iii) other project specific payments. The National Fund will receive 10% of these funds, and the State Funds will receive the remaining 90%.
- These Funds will be primarily spent on afforestation to compensate for loss of forest cover, regeneration of forest ecosystem, wildlife protection and infrastructure development.
- The Bill also establishes the National and State Compensatory Afforestation Fund Management and Planning Authorities to manage the National and State Funds.

10.4.3. Joint Forest Management (JFM)

- JFM is an initiative to institutionalize participatory governance of country's forest resources by involving the local communities living close to the forest.
- This is a co-management institution to develop partnerships between forest fringe communities and the Forest Department (FD) on the basis of mutual trust and jointly defined roles and responsibilities with regard to forest protection and regeneration.
- JFM started in consonance with the National Forest Policy 1988, which has recognized the importance of involving the local communities and the government has issued necessary resolutions and guidelines subsequently to initiate such institutions and strengthen it further.
- Most of the states in India have adopted JFM and issued resolutions permitting such partnership as per the prescribed guidelines though the institutional structure varies across the states.
- Under JFM, both forest departments and local communities come to an agreement to form the committee to manage and protect forests by sharing the costs and benefits.
- Forest departments take the initiative to form such committees directly by talking to the local community or through the help of NGOs working in specific areas.
- NGOs are also involved for capacity building, information dissemination, monitoring and evaluation and often act as the facilitators in constituting these participatory institutions.
- One of the key objectives of the JFM programme is the rehabilitation of degraded forestlands with people's participation involving Forest Protection Committees.
- JFM brings a win-win situation for both forest departments as well as the local communities in terms of greater access to minor forest produces from these regenerated forests.

10.4.4. Social Forestry

- The National Commission on Agriculture, Government of India, first used the term 'social forestry' in 1976.
- It was then that India embarked upon a social forestry project with the aim of taking the pressure off the forests and making use of all unused and fallow land.
- Government forest areas that are close to human settlement and have been degraded over the years due to human activities needed to be afforested.
- Trees were to be planted in and around agricultural fields. Plantation of trees along railway lines and roadsides, and river and canal banks were carried out. They were planted in village common land, Government wasteland and Panchayat land.

5 F's

- Social forestry also aims at raising plantations by the common man so as to meet the growing demand for food, fuel wood, fodder, fiber and fertilizer etc, thereby reducing the pressure on the traditional forest area.
- With the introduction of this scheme the government formally recognised the local communities' rights to forest resources, and encouraged rural participation in the management of natural resources. Through the social forestry scheme, the government has involved community participation, as part of a drive towards afforestation, and rehabilitating the degraded forest and common lands.

Social forestry scheme can be categorized into groups

Farm forestry

- Individual farmers are being encouraged to plant trees on their own farmland to meet the domestic needs of the family.
- Non-commercial farm forestry is the main thrust of most of the social forestry projects in the country today.
- It is to provide shade for the agricultural crops; as wind shelters; soil conservation or to use wasteland.

Community forestry

- It is the raising of trees on community land and not on private land as in farm forestry. All these programmes aim to provide for the entire community and not for any individual. The government has the responsibility of providing seedlings, fertilizer but the community has to take responsibility of protecting the trees.

Extension forestry

- Planting of trees on the sides of roads, canals and railways, along with planting on wastelands is known as 'extension' forestry, increasing the boundaries of forests. Under this project there has been creation of wood lots in the village common lands, government wastelands and panchayat lands.

Recreational forestry

- Raising of trees with the major objective of recreation alone.

10.5. POPULAR MOVEMENTS

10.5.1. Chipko Movement

- It is a social-ecological movement that practised the Gandhian methods of satyagraha and non-violent resistance, through the act of hugging trees to protect them from falling.
- The modern Chipko movement started in the early 1970s in the Garhwal Himalayas of Uttarakhand, with growing awareness towards rapid deforestation.
- The landmark event in this struggle took place on March 26, 1974, when a group of peasant women in Reni village, Hemwalghati, in Chamoli district, Uttarakhand, India, acted to prevent the cutting of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department.
- Their actions inspired hundreds of such actions at the grassroots level throughout the region.
- By the 1980s the movement had spread throughout India and led to formulation of people-sensitive forest policies, which put a stop to the open felling of trees in regions as far reaching as Vindhyas and the Western Ghats.
- The first recorded event of Chipko however, took place in village Khejarli, Jodhpur district, in 1730 AD, when 363 Bishnois, led by Amrita Devi sacrificed their lives while protecting green Khejri trees, considered sacred by the community, by hugging them, and braved the axes of loggers sent

by the local ruler, today it is seen an inspiration and a precursor for Chipko movement of Garhwal.

10.5.2. Appiko Movement

- Appiko movement was a revolutionary movement based on environmental conservation in India.
- The Chipko movement in Uttarakhand in the Himalayas inspired the villagers of the district of Karnataka province in southern India to launch a similar movement to save their forests.
- In September 1983, men, women and children of Salkani "hugged the trees" in Kalase forest. (The local term for "hugging" in Kannada is appiko.)
- Appiko movement gave birth to a new awareness all over southern India.

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CHAPTER - 11

SCHEDULE ANIMALS OF WPA 1972

11.1. SCHEDULE LIST-WPA, 1972

Wildlife Protection Act (WPA), 1972 consists of 6 schedule lists, which give varying degrees of protection.

Poaching, smuggling and illegal trade of animals listed Schedule 1 to schedule 4 are prohibited.

Schedule 1 and part II of Schedule 2

- Animals listed in schedule 1 and part II of schedule 2 have absolute protection - offences under these are prescribed the highest penalties.
- Examples of animals listed in schedule 1 are lion tailed macaque, rhinoceros, great indian bustard, narcondam hornbill, nicobar megapode, black buck, vulture, etc.
- Examples of animals listed in schedule 2 are rhesus macaque, dhole, Bengal porcupine, king cobra, flying squirrel, himalyan brown bear, mongoose, etc.

Schedule 3 and schedule 4

- Animals listed in schedule 3 and schedule 4 are also protected, but the penalties are lower compared to schedule 1 and part 2 of schedule 2.
- Examples of animals listed in schedule 3 are hyaena, hogdeer, nilgai, goral, sponges, barking deer, etc.
- Examples of animals listed in schedule 4 are desert cat, desert fox etc.

Do you know?

Bear hibernation is different than most hibernating animals. True hibernation (like we see in ground squirrels) involves a drastic drop in body temperature but the hibernating animal will awaken occasionally to eat and defecate before resuming hibernation. When a bear 'hibernates' it is really in a deep sleep. It's body temperature drops but not drastically and it does not wake up. The one exception is that a mother bear will wake up to give birth in January or February. Since food is scarce in the winter bears figure that if you can't eat you might as well sleep. Bears like the Asiatic Bear live in warmer climates where food is readily available all year long and there is no need to hibernate.

schedule 5

- Animals listed in schedule 5 are called "vermin" which can be hunted.
- Mice, rat, common crow and flying fox (fruit eating bats) are the list of animals (only 4 nos) in schedule 5 [i.e. vermin].

Schedule 6

- Cultivation, Collection, extraction, trade, etc. of Plants and its derivatives listed in schedule 6 are prohibited.
- Red Vanda, blue Vanda, kuth, pitcher plant, beddomes cycad and ladies slipper orchid are the list of plants listed in schedule 6.

Description of Animals listed in Schedule 1 to 4 of WPA, 1972 according to Bio-geographic Zones of India

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
			TRANS HIMALAYAN REGION		
1.	Bharal	Least Concern	Bhutan, China, Northern India, Northern Myanmar, Nepal, North Pakistan. Blue Sheep - North Himalaya & Trans Himalaya - along the border of Arunachal Pradesh. Ladak, Himachal Pradesh, U.P., Sikkim and Eastern Arunachal Pradesh & recently conformed in Western Arunachal Pradesh	Open grass slopes in high mountain from 2500 - 5500 m avoid entering forest area	Competition with livestock, habitat destruction due to livestock.
2.	Himalyan Ibex	Least Concern	Central & Northeast Afghanistan, China, North (India) - Hima of Jammu and Kashmir & Himachal Pradesh Hindu Kush range (Karakoram, Trans-Himalayan)	Mountain, open alpine meadow & crags (not in forest zone)	Hunted for food. Habitat loss due to competition with livestock.
3.	Markhor	Near threatened	Northeast Afghan, Northern India (J & K), Pakistan, Uspekistan. "Pirpanjal range", Banihal pass on Jammu - Srinagar highway.	Mountain terrain 600 m - 3600 m - feeds on grasses & leaves.	Hunting and Habitat Alteration. (Armed conflict).
4.	Snow leopard	Vulnerable	High mountain of C.A, Pamir, Karakorum, Hindu Kush and Himalayan Range. India - "J.K., H.P., Sikkim, Uttarkhand).	Alphine & Sub alphine ecological zone favouring steep terrain.	Reduce in prey, illegal trade, people conflict, lack of conservation capacity policy & awarness.

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
5.	Chiru	Near threatened	China, India (J & K)	High altitude plain, hill plateau & Montane valley	Hunted for fur (Shahtosh) Quality - making "shawls"
6.	Tibetan Fox	Least Concern	Tibetan Plateau, Ladak area of India, China, Nepal	Upland plains, hills - mostly spare grassland devoid of trees & shrub	No Major threat
7.	Tibetan Gazelle	Near threatened	Qinghai - Tibet Plateau, India (ladak, Sikkim).	High altitude plains, hills also grasses in wetland margin.	Habitat loss.
8.	Kiang (Wild Ass)	Least Concern	Tibetan Plateau, China, Northern Pak, India, Nepal) Ladak & Sikkim	Open terrain, plains, alphine meadows - where grasses & sedges abundant.	Hunting, disease transmission from domestic livestock.
9.	Urial	Vulnerable	India - Only (laddak), Central and South West Asia.	Moderate to arid habitat grassland.	Poaching, Competition with livestock.
10.	Black Necked-Crane	Near threatened	China, Ladakh (A.P.) - India, Bhutan	Alpine bog meadows & riverine marshes, lacustrine marshes.	Intensive grazing & pesticide use - result in degradation of grassland.
			HIMALAYAN REGION		
11.	Binturong	Vulnerable	India - Sikkim, Bangladesh, Bhutan Myanmar, China	Arboreal animal, feed on fruits, insects, birds.	Habitat loss and degradation.
12.	Brown Beer	Critically Endangered	India (Jammu and Kashmir, Himachal Pradesh, Uttarkhant), Nepal, Pakistan, China	Temperate rain forest. (Northern India, Western China)	Man - animal conflict
13.	Chinese Pangolin	Critically Endangered	Occur in Himalayan foot hills in Eastern Nepal, Bhutan, Northern India, North East Bangladesh (India - Sikkim)	Primary & Secondary tropical forest, lime stone forest, bamboo forest, grassland & agricultural field. Nocturnal animal	Habitat loss, hunting for local use trade skin, scales & meat

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
14.	Clouded Leopard	Vulnerable	Himalayan foot hill in Nepal through mainland South East Asia - China	Arboreal, forest habitat (Primary every green tropical rain forest, also in dry deciduous forest Himalaya - 2500 m.	Habitat destruction. Hunted for skin, bones for medicine, captive animal
15.	Golden Cat	Near threatened	Himalayan foothills into China and South East Asia	Forest habitat ranging from tropical and subtropical evergreen to mixed & dry deciduous forest	Habitat loss to deforestations, illegal trading
16.	Himalayan Thar	Near threatened	Himalaya China (Southern Tibet), North India (J.K. to Sikkim) & Nepal (Uttarkhand, H.P.).	Steep rocky mountain side (3000-4000). Grass, herb & fruit.	Uncontrolled hunting & deforestation, habitat lose due to livestock grazing.
17.	Hog budger	Vulnerable	Central to South east Asia. Mongolia, India (Sikkim, Terai, Assam, A.P.), China, Indonesia, LaoPDR, Myanmar	Diurnal, forested area (tuberroot, earthworm, insects). 1) grass land - India Terai (Evergreen Forest)	Hunting by Dogs & Man.
18.	Leopard Cat	Least Concern	Widespread up in Asia. Most of India west into pak. Afgh, through Himalayan foothill - across China, Russia.	Upto 3000m, extent into river valley - Tropical to temp broad leaf, coniferous, grassland, cold steppe to desert Pakistan	Commercial exploitation for skin. Leopard Cat X Domestic Cat - hybridisation is also not threat.
19.	Marbled Cat	Vulnerable	Tropical Indo-Malaya westward along Himalayan foot hills - Nepal & China, Sumatra Borneo.	Moist - Mixed decidous evergreen tropical forest	Deforestation - due to oil palm, logging, agriculture.

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
20.	Himalayan Musk Deer	Endangered	Himalayan of Bhutan, North India (Sikkim), Nepal & China	Alpine environment, barren plateaus at high altitude meadows, fell fields, shurblands forest	1. Hunting for Meat. 2. Trade - Musk gland - Cosmetic / Pharmaceutical
21.	Indian Pangolin	Endangered	South asia, Eastern part of pak to India (Except North East India). Himalayan to extreme South. India (TN, Kerala)	Tropical forest, open land, grasslands, etc. High in human settlement area.	Meat & Medicine. (for boots & shoes)
22.	Himalayan Serow	Vulnerable	Southeast Bangladesh, Himalaya (Bhutan, Northern India - Sikkim & Nepal), North east India & into west myanmar	Steep hills & rocky places - limestone region upto 3000 m & hill & mountain foreat area.	Meat & tropics, habitat destruction, for agriculture, fuelwood.
23.	Asia - small clawled otter	Vulnerable	India - Himalayan foothills of H.P. (Kulu), WB, Assam, A.P. & S.I. - Coorg (Karnataka), Ashambu, Nilgiri, Palani Hill (TN), Kerala	Wetland system - having pools & stagnant water. Fresh water swamp, meandering river, mangroves & tidal tools.	Habitat destruction. Tea & Coffee cultivation
24.	Cheer Pheasant	Vulnerable	India - Kashmir, H.P., Uttarkhand, Pakistan, Nepal	Rocky terrain dominated by scrub, tall grass & scattered clumb tree (1445 - 3050m)	Hunted, egg consumption, construction project (dam, electricity).
25.	Goral (or) Wodgsoni	Near threatened	Bhutan, China (Southern Tibet) Northern India (Incl SIKKIM) Northern Pakistan Possibly Western Myanmar	1. Steep Mountains & will use evergreen forest near cliff 2. feed in grassy rights & steep rocky slopes	Habitat destruction Hunting competition of livestock

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
26.	Sambar	Vulnerable	India, East along Southern Himalayas India, Nepal, Bhutan, Srilanka	1. India - Thorn, arid forests of Gujarat & Rajasthan 2. Moist decidiuous forest throughout Peninsular 3. Pine & Oak trees at himalayan forest	1. Habitat encroachment 2. Hunting
INDIAN DESERT					
27.	Caracal desert lynx	Least Concern	Africa, Central Asia, South West Asia into India	Semi - desert to open tropical grassland	Habitat, destruction, hunting
28.	Sand Cat	Least Concern	Only found in true desert. Northern Africa, Southwest & Central Asia	Specialist of sand desert, localized around spare regetation which can support small rodent prey.	Habitat degradation major threat - by human settlement and livestock grazing
SEMI-ARID ZONE					
29.	Cheetah	Vulnerable	1. Extint - Central - India & Pakistan 2. Asiastic Cheetah (critically endangered) - Iran - only	Open Grassy habitat, dry forest, savanna woodland, semi - desert - absent in tropical rain forest	Habitat loss, fragmentation, loss of prey - due to human hunting activities. livestock damage - hunting by man.
30.	Indian Gazelle (Chinkara)	Least Concern	Western & Central India through Pakistan, South-West Afghan. (Thar desert remains strong hold)	Inhabits arid area, Sand deserts, Flat plains & hills, dry scrub & light forest.	Habitat loss through overgrazing, conversion to agriculture & industrial development
31.	Asian Caracal (Lynx)	Least Concern	Africa, Centralasia, Southwest Asia into India	Semi desert, open savanna to moist wood land, evergreen forest.	Habitat destruction, Hunting due to its attack on livestock

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
32.	Gharial	Critically endangered	India - Chambal River, Girwa river. Pop - Son River Bihar, U.P.	Terrestrial, Fresh Water	Alternation of habitat, Fishing, Agriculture, grazing, utilization
33.	Hogdeer	Endangered	Pakistan, North & North Eastern India east across non-sundalic region Marginally - Southern China	1. Wet (or) Moist tall grassland 2. Floodplain grassland	Hunting habitat cons degradation
			WESTERN GHATS		
34 (a)	Indian / Malabar Gaint aquirtel	Near threatened	Southwestern, Central, Eastern Peninsular India (W.G., E.G. & Satpura) AP, Kar, TN, M.P. Mah, Chatti, Jhar, Gujar, Kerala	Diuval - arboreal sp. Tropical evergreen, semi evergreen & Moist decidous forest. High Cannopy	Habitat degradation - agriculture and plantation, Monoculture, dam, Hunting.
34 (b)	Grizzled giant squirrel	Near threatened	Southern India (Kerala, TN) Srilanka	Tropical dry decidous & Montane forest	Habitat degradation agriculture and plantation, Monoculture, dam, Hunting.
35.	Loin tailed Macaque	Endangered	Endemic "Western Ghat hills range in South Western India (Karnataka, Kerala, Tamil Nadu)	Upper canopy of primary tropical evergreen rainforest - Monsoon forest in hilly country	Habitat fragmentation (Exotic plant - tea, Eucalyptus, Coffee)
36.	Indo-pacific Finlers porpoise	Critically Endangered	Malabar West of India	Coastal water, Shallow bay, Mangrove, Swamps and Estuaries.	Susceptible to entanglement in gillnets. Pollution boat traffic.
37.	Malabar Civet	Critically Endangered	Endemic western ghat, Coastal district of Western Ghats. Kanyakumari to Wayanad, Coorg - Karnataka	Lowland forest, lowland swamp and riparian forest in coastal plain district	Habitat loss & degradation. Poaching for civet oil

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
38.	Nilgiri Langur	Vulnerable	Western Ghats in South Western India (Karnataka, Kerala, TN)	Evergreen, Semi-evergreen Moist deciduous & riparian forest in lower altitude	Hunted for skin, Medicine, Habitat loss, Mining, dam, road fills.
39.	Nilgiri Tahr	Endangered	5% of West Ghats in South India (Kerala & Tamil Nadu)	High elevation, grass covered hills, open terrain	Habitat loss & poaching.
40.	Sloth Bear	Vulnerable	India, Nepal, Bhutan, Srilanka (From Gujarat - to NES) Western Ghats	Wet & dry tropical forest, grasslands. Lowland species - 1500 m W.G. - upto 2000 m	Habitat loss, poaching (harvesting of forest produce, Monoculture) (Medicine) - fat of bear
41.	Travancore Flying squirrel	Near Threatened	Restricted to W.G. of Southern India and Srilanka. kerala & T.N. (from Brahmagiri Wildlife Santuary, Karnataka).	Arboreal & Nocturnal Evergreen, decidous and montane forest	Habitat loss due to agriculture & human settlement.
			DECCAN PENINSULA		
42.	Ermine	Least Concern	Throughout North America, Europe, Asia, Greenland, Canada, Siberia, India.	Forest edge habitat, scrub, alpine meadow, marshes, riparian woodland, hedgerows.	No major threat Habitat destruction due to timber loss.
43.	Four horned antelope	Vulnerable	2008 - Widely distributed but in scattered population over most of India - From Himalaya foothills to Peninsular India. (Nepal. India)	Found in well-wooded undulating (or) hilly area and never far from water, they are solitary & browse & graze.	Habitat destruction through the clearance of scrub & forest for agriculture.

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
44.	India Gaur	Vulnerable	Gaur historically occured throughout main land south. South east asia, Srilanka.	From sea level upto least 2800m. (hill & low lying area.) 1. undisturbed forest tact, 2. hilly terrain 3. availability of water. 4. availability of coarse grasses	Hunting, Habitat degradation, forest fragmentation with human population.
45.	Leopard	Vulnerable	Southwest Asia, Himalayan foothills, India, China, Jawa, Srilanka "Leopards occur widely in forest of India - sub continent.	Rainforest to desert. India - all forest type-tropical rainforest to temp deciduous and alpine coniferous.	Habitat loss, (deforestation) peaching for illegal trade. Human attack on people.
46.	Red Slenderlori Gray Slenderlori	Endangered Endangered	Srilanka Southern eastern India (Andhra Pradesh, Kar, Kerala, TN) Srilanka	Primarily insectivorous Near human habitation	Habitat loss due to road kills, electrification, Medicine uses.
47.	Mouse Deer	Least Concern	India - from T.N. & Kerala infar south - north upto Rajasthan	Tropical deciduous, Moist evergreen & Semi ever-green forest of Peninsular hill	Hunting (for Meat purpose) - W.G. & E.G.
48.	Rusty spotted Cat	Near threatened	India & Srilanka (confined to south)	Moist & dry deciduous forest types, scrub & grassland - absent in evergreen forest.	Habitat loss due to agriculture
49.	Tiger	Endangered	Southwest Asia, Central Asia, (Java & Bali) - disappeared. Asian Countries - Bang, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Russia, Thailand & Vietnam	Forest of tropical Asia	Poaching, Man animal conflict, (bore anti-inflammatory property)

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
50.	Indian Buffalo	Endangered	S. Nepal, Southern Bhutan, Western Thailand, Northern Myanmar, India (Bastar region - M.P., Assam, AP, Meghalaya, Orissa, Maharastra)	Low - lying Alluvial grassland, deciduous forest - with marshes & rivers.	Interbreeding with feral & domestic buffalo, hunting & habitat loss.
51.	Forest Owlet	Critically endangered	Endemic - Central India, (North - Western Maharashtra, South-east M.P. Till 1997 only specimen, 2000 rediscovered.	Open dry deciduous forest dominated by Teak, ground with grasses - typical owlet site.	Forest destruction, human settlement & grazing.
52.	Chital	Least Concern	8 - 30° N in India (Including SIKKIM), Nepal, Bhutan, Bangladesh, Srilanka WB - Eastern Rajasthan NB - Foothills & Himalayas EB - Western Assam SB - Throughout Peninsular India	1. Avoids - Dense Moist forest Open semi arid & arid desert 2. Moist, dry deciduous day thorny scrub (or) grasslands Habitat	Hunting & Competition with domestic livestock No Major threat
53.	Wild Pig	Least Concern	Occur in modified form in all continents except in Antarctica & on many oceanic Islands	1. Temperate & tropical habitats 2. Semi desert to tropical rainforest	1. Global lenes & No major threats 2. local lenes & Hunting & habitat destruction.
54.	India's Procupine	Least Concern	Turkey to Pakistan, India, China, Nepal & Srilanka	1. Rocky hill side 2. Tropical & temperate scrub land	Considered as Agricultural Pest - locals trap & use them for food.
55.	Barking Deer (or) Muntjac	Least Concern	Thai - Malay Peninsula, Greater Sundas (Borneo, Java, Bali, Sumatra)	1. In forest & areas adjacent to forest 2. In plantations of coffee rubber, sugarcane, teak	Habitat encroachment & Hunting for freshmeat.

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
GANGETIC PLAINS					
56.	Fishing Cat	Endangered	Asia - Pakistan - Indus Valley India - Nagpur, Himalayan foothill & Eastern India. (Keoladeo National Park)	Wetland (Swamp and marshy), Oxbow lake, reed beds, mangroves. Evergreen & tropical dry forest.	Wetland destruction 45% of wetland 94% of globally significant wetland - threatened. eg: Human settlement, agricultural pollution, hunting & Wood cutting.
57.	Ganges river Dolphin	Endangered	Indus Ganges - Brahmaputra Megna, Karnaphuli - Sangu river system of south. Asian subcontinent, from upstream to where they blocked by barrier.	Cone in counter - current pools below channel convergence meanders. Can't tolerate salinity > 10 ppt.	1. Water development project 2. Fragmenting of pop, dams, barrages. 3. Pollutant loads. 4. Deliberate killing 5. Mortality in fishing gear
58.	Hispid Hare	Endangered	From Uttar Pradesh through Nepal, West Bengal to Assam (W.B., Assam, Bihar, U.P.)	Tall grassland (Elephant Grass)	Habitat loss, agri, logging, flood control and HD
59.	Swamp Deer	Vulnerable	Northern & Central India, Southwestern Nepal (Assam - Sunderbans (Indo - Gangetic)	Open sal, with grass understorey and grassland forms, true swamp deer, Mangroves of Sunderban.	Habitat loss - due to conversion into agriculture land.
60.	India Softshell Turtle	Critically endangered	Bangladesh, India (Ganges River), Pakistan	Terrestrial, Fresh Water	Trade in East Asian Market

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
61.	Bengal Florican	Critically endangered	Two population 1. Indian Sub Continent - (U.P., Nepal, Assam, A.P.) 2. South - East Asia - Cambodia, Vietnam.	lowland dry, natural & semi-natural grassland, open forest.	Modification of grassland, overgrazing, inappropriate cutting, burning & ploughing regimes, flooding, dam construction, illegal development.
62.	Hyena	Endangered	Africa, Arab peninsula Turkey. Indian Sub-continent recently to Nepal	1. Open habitat (or) light thorn 2. Avoids & open Desert	Persecution (poisoning) decrease in source
63.	Nilgai	Least concern	Widely distributed in India. lowland of Nepal & border areas of Pakistan extinct in Bangladesh	1. Arid areas, scrub, dry deciduous, agricultural areas 2. Avoid - Dense Forest, deserts 3. Browsers & grazers	1. Constructed as agricultural pest 2. Permit hunting if damage occurs.
			COASTS		
64.	Dugong Dugong (Sea Cow)	Vulnerable	Coastal Island water belt East Africa & Vanuate belt latitude 27° N - South of Eq (India - Andaman & Nicobar, Laccadives)	Coastal water, wide shallow mangroove & sizeable sea grass bed.	Habitat & degradation loss Indigenous use & hunting, pollution
65.	Snubfin Dolphin	Vulnerable	Southeast Asia, India - Chilika lake.	Coastal area with muddy, brackish water at river mouth.	Habitat loss and degradation.

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
66.	Green Turtle	Endangered	Throughout tropical water, lesser - subtropical. Indian ocean - east, west, mediterranean Sea, Pacific ocean	Highly migratory, broad habitat during their lifetime.	Harvest of egg & Adult from nesting beaches, retting, trawling.
67.	Hawsbill Turtle	Critically endangered	Throughout tropical water, larger extent subtropical, Atlantic, Indian, Pacific Ocean	Highly migratory, broad habitat - during life time.	Tortoises shell trade Egg collection, meat, Destruction of Nesting habitat, Foraging habitat, oil pollution, hybridisation
68.	Leather Back Turtle	Vulnerable	Leather back are distributed, with nesting site on tropical sandy beaches & foraging range that extent into temp / sup polar.	Turtle inhabiting tropical, subtropical & sub polar extensive migration, different feeding area at different season.	Habitat destruction, pollution, climate change, Fisheries by Catch.
69.	Olive Ridly	Vulnerable	Throughout tropical water (Except Mexico).	Multiple habitat, Migration less compared to other usually carred by major currents	Targeted Exploitation, capturing, by catch in fisheries, Habitat impact, disease & predation
	NORTH EAST INDIA				
70.	Brown antlered Deer	Endangered	South & South East Asia, Manipur (Southern end of loktak lake) region of N.E. India through Myanmar.	Open, Grass dominated habitat.	Hunting, Medicinal Product, Habitat loss. “Hydroelectric Power Project - loktak lake

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
71.	Capped Langur	Vulnerable	Bangladesh, Bhutan (N.E. India - A.P., Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura) Brahmaputra (Karbi Anglong, Khasi, Garo, Naga & Jaintia hills) & Myanmar	Diurnal, arboreal, broadleaf, deciduous & bamboo forest	Habitat destruction, jhum cultivation, monoculture, timber and firewood harvest. Traded for meat purpose.
72.	Golden Langur	Endangered	Bhutan and North-east India (Assam). Forest beltwest Assam between manas river in east, sankosh - Brahmaputra	Moist evergreen, diptero carp, riverine & moist deciduous forest	Habitat destruction, Hunting.
73.	Hoolock Gibbon 1) Western	Endangered	Northeast India, Bangladesh (A.P., Assam, Manipur, Meghalaya, Tripura, Mizoram, Nagaland) Upto South of Brahamaputra & East of Dibang	Forest dweller, locale, inhabit tropical evergreen (Tree to tree more)	Habitat loss, fragmentation, human interferences hunting,
	2) Eastern	Vulnerable	Southern China & Chindwin river Myanmar. Boundary between (2) Hoolock gibbon uncertain in chindwin head water. India not found (Expect Eastern A.P.)	Hill forest, Mountainous, piro dominated forest	Habitat loss, fragmentation, human interferences hunting,
74.	Red Panda	Endangered	Nepal, India, Bhutan, Myanmar, Southern China. (Meghalayan Plateau - North east India).	Temparate Forest - having bamboo - thickest under stories	Habitat loss, Fragmentation Poaching, inbreeding depression.
75.	Sun Bear	Vulnerable	Southeast Asia, North eastern India, Southern China, Bangladesh	Tropical forest habitat, Mangroves, Swamp	Habitation, Commercial Hunting.

S. No.	Common Name	Category	Range Description	Habitat & Ecology	Major threat
76.	Pygmy Hog	Critically Endangered	Northwest Bengal & North - Western Assam in India. Himalayan foot hill from Up to Assam	Smallest & Rarest wild pig in world. Grassland - with shrub & tree	Habitat loss, affecting natural succession.
77.	Greater onehorn Rhino	Vulnerable	Northern part - India along Indus, Ganga, Brahmaputra basin includes Nepal, Bhutan, Bangladesh, Pakistan	Riverine grassland - Terai. Alluvial grass land - swamps & forest	Habitat loss, Poaching for horn - Medicinal use in China.
78.	Bengal slow lori	Endangered	Bangladesh, Cambodia, China, North - Eastern India (A.P., Assam etc).	Arboreal, nocturnal species - tropical evergreen forest, semi & moist deciduous forest.	Habitat loss - Farming, road building, dam, power line. Hunting - Medicine.
79. (a)	Terrapin	Critically Endangered	Bangladesh, India, Cambodia, India, Indonesia, Malaysia.	Terrestrial nest sites, tidal area of largest river estuaries	Trade
79. (b)	Tricarinate Hill Turtle	Vulnerable	Bangladesh, India	Fully terrestrial	-
			ISLANDS		
80.	Andaman Wild Pig	Least Concern	Andaman	Temperate to Tropical Habitat	Habitat destruction and hunting pressure.
81.	Crab eating Macaque	Endangered	Occurs on Nicobar Island of India, (Little Nicobar & Great Nicobar) where it found up to 600 m.	Grassland, Mangrove, swamp forest and can be found in agricultural area near forest.	Hunting, Habitat loss.

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CHAPTER - 12

ANIMAL DIVERSITY OF INDIA

12.1. MAMMALS - CRITICALLY ENDANGERED

12.1.1. Pygmy Hog (Porcula salvania)

- It is the world's smallest wild pig, with adults weighing only 8 kgs. This species constructs a nest throughout the year.
- It is one of the most useful indicators of the management status of grassland habitats. The grasslands where the pygmy hog resides are crucial for the survival of other endangered species such as Indian Rhinoceros, Swamp Deer, Wild Buffalo, Hispid Hare, Bengal Florican and Swamp Francolin.
- In 1996, a captive-breeding programme of the species was initiated in Assam, and some hogs were reintroduced in Sonai Rupai area in 2009.
- Habitat: Relatively undisturbed, tall 'terai' grasslands.
- Distribution: Formerly, the species was more widely distributed along the southern Himalayan foothills but now is restricted to only a single remnant population in Manas Wildlife Sanctuary and its buffer reserves.
- Pygmy hog-sucking Louse (Haematopinus oliveri), a parasite that feeds only on Pygmy Hogs will also fall in the same risk category of critically endangered as its survival is linked to that of the host species.
- Threats: The main threats are loss and degradation of grasslands, dry-season burning, livestock grazing and afforestation of grasslands. Hunting is also a threat to the remnant populations.

Do you know?

Dart Frogs got their name because hunters would tip their arrows in the frog's poisons. Sadly, because people are cutting down rainforests for farming and ranching, Poison Dart Frogs are at risk. The Blue Poison Dart Frog is the most endangered due to the pet-shop market.

12.1.2. Andaman White-toothed Shrew (Crocidura andamanensis), Jenkin's Andaman Spiny Shrew (Crocidura jenkinsi) and the Nicobar White-tailed Shrew (Crocidura nicobarica)

- These animals are endemic to India.
- They are usually active by twilight or in the night and have specialized habitat requirements.
- Habitat: Leaf litter and rock crevices.
- Distribution:
    - The Andaman White-toothed Shrew is found on Mount Harriet in the South Andaman Islands.
    - The Jenkin's Andaman Spiny Shrew is found on Wright Myo and Mount Harriet in the South Andaman Islands.

- The Nicobar White-tailed Shrew (Crocidura nicobarica) is found in the southern tip of Greater Nicobar Island and is also recorded in the area extending from the Campbell Bay National Park to the Galathea River in the Andaman and Nicobar Islands.
- Threats: Habitat loss due to selective logging, natural disasters such as the tsunami and drastic weather changes.

Do you know?

Penguins don't live near freshwater. they drink salt water. They have a special gland in their bodies that takes the salt out of the water they drink and pushes it out of grooves in their bill. A handy in-house filtration system!

12.1.3. Kondana Rat (Millardia kondana)

- It is a nocturnal burrowing rodent that is found only in India. It is sometimes known to build nests.
- Habitat: Tropical and subtropical dry deciduous forests and tropical scrub.
- Distribution: Known only from the small Sinhagarh Plateau (about one km^2), near Pune in Maharashtra. Reported from an elevation of about 1,270 m above mean sea level.
- Threats: Major threats are habitat loss, overgrazing of vegetation and disturbance from tourism and recreational activities.

Do you know?

Tiger, delineates its own territory by urinating on the trees and rocks along the boundary and lives within that. Trespass by another male usually ends up in conflict which turns into a bloody battle sometimes. The tigresses in a family may have overlapping territories within the male's territory.

Even though tiger is a powerful predator with plenty of tactics, it is observed that only one in twenty attempts of hunting is really successful.

12.1.4. The Large Rock Rat or Elvira Rat (Cremnomys elvira)

- It is a medium sized, nocturnal and burrowing rodent. endemic to India.
- Habitat: Tropical dry deciduous shrubland forest, seen in rocky areas.
- Habitat / distribution: Known only from Eastern Ghats of Tamil Nadu. Recorded from an elevation of about 600 m above mean sea level.
- Threats: Major threats are habitat loss, conversion of forests and fuel wood collection.

Do you know?

The major difference Tortoise vs turtle being that the land dwelling ones are called Tortoises and water dwelling are called Turtles. Tortoise are herbivorous where as turtle are omnivorous

12.1.5. The Namdapha Flying Squirrel (Biswamoyopterus biswasi)

- It is a unique (the only one in its genus) flying squirrel that is restricted to a single valley in the Namdapha N.P. (or) W.L.S. in Arunachal Pradesh.
- Habitat: Tropical forest.
- Habitat / distribution: Found only in Namdapha Tiger Reserve in Arunachal Pradesh.
- Threats: Hunted for food.

Do you know?

Cobras are cannibals, which mean that they will eat other snakes along birds, bird eggs and small mammals

12.1.6. The Malabar Civet (Viverra civettina)

- It is considered to be one of the world's rarest mammals.
- It is endemic to India and was first reported from Travancore, Kerala.
- It is nocturnal in nature and found exclusively in the Western Ghats.

- Habitat: Wooded plains and hill slopes of evergreen rainforests.
- Habitat / distribution: Western Ghats.
- Threats: Deforestation and commercial plantations are major threats.

Do you know?

The Spitting Cobra spits venom which can spray more than 1.8 meters, or 6 feet. It has near perfect aim, and will fire straight into the eyes of it's prey.

12.1.7. The Sumatran Rhinoceros (Dicerorhinus sumatrensis)

- It is the smallest and most endangered of the five rhinoceros species.
- It is now thought to be regionally extinct in India, though it once occurred in the foothills of the Himalayas and north-east India.
- The Javan Rhinoceros (Rhinoceros sondaicus) is also believed to be extinct in India and only a small number survive in Java and Vietnam.

Do you know?

Sharks have the most powerful jaws on the planet. Both the upper and lower jaws move. It tosses its head back and forth to tear loose a piece of meat which it swallows whole.

12.1.8. Kashmir stag/ hangul (Cervus elaphus hanglu)

- It subspecies of Red Deer which is native to India.
- Habitat / distribution - in dense riverine forests, high valleys, and mountains of the Kashmir valley and northern Chamba in Himachal Pradesh.
- State animal of J&k.
- Threat - habitat destruction, over-grazing by domestic livestock, and poaching.

Do you know?

Indian Water Monitor lizard is one of the largest as well as the heaviest species of lizards, second only to the Komodo Monitors

12.2. MARINE MAMMALS

12.2.1. Freshwater / river dolphin

- Habitat / distribution - India, Bangladesh, Nepal and Pakistan which is split into two subspecies, the Ganges river dolphin and Indus river dolphin.

Ganges river dolphin

- Habitat / distribution - Ganges and Brahmaputra Rivers and their tributaries in Bangladesh, India and Nepal.
- The Ganges river dolphin is important because it is a reliable indicator of the health of the entire river ecosystem.
- The Ganges river dolphin has been recognized by the government of India as its National Aquatic Animal.

Indus river dolphin

- Habitat / distribution - Indus River in Pakistan and its Beas and Sutlej tributaries.
- It is declared as the state aquatic animal of Punjab.

12.2.2. Herbivorous Marine Mammals

- These include dugong and manatees and they inhabit swamps, rivers, estuaries, marine wetlands, and coastal marine waters.

Dugong

- (Dugong dugon) also called as sea cow.
- Status - vulnerable. Threat - hunting (meat and oil), habitat degradation, and fishing-related fatalities.
- Tamil Nadu government is on path with the establishment of India's first conservation reserve for the Dugong in Gulf of Mannar, Palk Bay.

- The Ministry of Environment, Forests and Climate Change constituted a 'Task Force for Conservation of Dugongs' to look into issues related to conservation of dugongs.

Manatees

- Habitat / distribution - Caribbean Sea, Gulf of Mexico, the Amazon Basin, and West Africa
- Threat - coastal development, red tide, hunting.

Do you know?

Sharks give birth to pups in three ways

I. eggs are laid (like birds)
II. eggs hatch inside the mother and then are born
III. pups (sharks) grow inside the mother.

12.3. FEW EXCEPTIONS

12.3.1. Egg Laying Mammals

The unique feature of monotremes, a sub division of mammal, is that monotremes lay eggs rather than giving birth to their young. Only five living Monotreme/ egg laying Mammals species: they are - the duck-billed platypus and four species of spiny anteaters (also known as echidna). All of them are found only in Australia and New Guinea.

Echidnas are also known as spiny ant eaters.

- Habitat / distribution - Australia and New Guinea
- In echidnas, the egg is carried in a pouch on the female's belly until the young hatches, at which point the barely-developed young must find a mammary gland and latch onto it for nourishment.

Platypus is a semi-aquatic mammal.

- Habitat / distribution - endemic to eastern Australia, including Tasmania.
- In the platypus, the female retires to a burrow in the bank of a river or pond. The burrow is lined with dry vegetation, and there the eggs are laid.
- The male platypus has venom strong enough to can kill a small dog, or cause excruciating pain among humans.

12.3.2. Marsupials

- Marsupials are the group of mammals commonly thought of as pouched mammals (like the wallaby and kangaroo).
- Marsupial mammals have placenta but it is very short-lived and does not make as much of a contribution to fetal nourishment.
- They give birth very early and the young animal, essentially a helpless embryo, climbs from the mother's birth canal to the nipples.
- There it grabs on with its mouth and continues to develop, often for weeks or months depending on the species.
- They do not have long gestation times like placental mammals. The short gestation time is due to having a yolk-type placenta in the mother marsupial.
- Extinct Marsupial - quagga, the marsupial wolf.
- Placental mammals all bear live young, which are nourished before birth in the mother's uterus through a specialized embryonic organ attached to the uterus wall, the placenta.
- Placental mammals nourish the developing embryo using the mother's blood supply, allowing longer gestation times.
- Some of Marsupials are Phalangers, Opossum, Kola, Tasmanian devils, Kangaroo, Mursupial Mole (4 foot), Wallaby, Bandi coot, Wombats, Tasmanian Wolf /Tiger and Dasyure

Do you know?

Not all sharks are fierce carnivores. Some are quite harmless. Oddly enough, the most harmless sharks tend to be the largest! The basking shark, the whale shark and the Mega mouth sharks all fit this description. These huge sharks eat plankton.

12.4. BIRDS - CRITICALLY ENDANGERED

12.4.1. The Jerdon's Courser

- It is a nocturnal bird found only in the northern part of the state of Andhra Pradesh in peninsular India.
- It is a flagship species for the extremely threatened scrub jungle.
- The species was considered to be extinct until it was rediscovered in 1986 and the area of rediscovery was subsequently declared as the Sri Lankamaleswara Wildlife Sanctuary.
- Habitat: Undisturbed scrub jungle with open areas.
- Distribution: Jerdon's Courser is endemic to Andhra Pradesh.
- Threats: Clearing of scrub jungle, creation of new pastures, growing of dry land crops, Illegal trapping of birds, plantations of exotic trees, quarrying and the construction of the River Canals.

12.4.2. The Forest Owlet

- Had been lost for more than a century. After 113 long years, the owlet was rediscovered in 1997 and reappeared on the list of Indian birds.
- Habitat: Dry deciduous forest.
- Habitat / distribution: South Madhya Pradesh, in north-west Maharashtra and north-central Maharashtra.
- Threats: Logging operations, burning and cutting of trees damage roosting and nesting trees of the Forest Owlet.

Do you know?

Russell's Viper is responsible for the more deaths due to snakebite than any other venomous snake. It is highly irritable and when threatened, coils tightly, hisses, and strikes with a lightning speed. Its hemotoxic venom is a very potent coagulant, which damages tissue as well as blood cells.

12.4.3. The White-bellied Heron

- extremely rare bird found in five or six sites in Assam and Arunachal Pradesh, one or two sites in Bhutan, and a few in Myanmar.
- Habitat: Rivers with sand or gravel bars or inland lakes.
- Distribution: Bhutan and north-east India to the hills of Bangladesh and north Myanmar.
- Threats: Loss and degradation of lowland forests and wetlands through direct exploitation and disturbance by humans.

12.4.4. The Bengal Florican

- A rare bustard species that is very well known for its mating dance. Among the tall grasslands, secretive males advertise their territories by springing from the ground and flitting to and fro in the air.
- Habitat: Grasslands occasionally interspersed with scrublands.
- Distribution: Native to only 3 countries in the world - Cambodia, India and Nepal. In India, it occurs in 3 states, namely Uttar Pradesh, Assam and Arunachal Pradesh.
- Threats: Ongoing conversion of the bird's grassland habitat for various purposes including agriculture is mainly responsible for its population decline.

12.4.5. The Himalayan Quail

- It is presumed to be extinct since no reliable records of sightings of this species exist after 1876. Intensive surveys are required as this species is hard to detect due to its reluctance to fly and its preference for dense grass habitats. Possible sighting of this species was reported in Nainital in 2003.
- Habitat: Tall grass and scrub on steep hillsides.
- Distribution: Western Himalayas.

- Threats: Indiscriminate hunting during the colonial period along with habitat modification.

12.4.6. Pink- headed Duck

- It has not been conclusively recorded in India since 1949. Males have a deep pink head and neck from which the bird derives its name.
- Habitat: Overgrown still-water pools, marshes and swamps in lowland forests and tall grasslands.
- Distribution: Recorded in India, Bangladesh and Myanmar. Maximum records are from north-east India.
- Threats: Wetland degradation and loss of habitat, along with hunting are the main causes of its decline.

12.4.7. Sociable Lapwing (Vanellus gregarious)

- It is a winter migrant to India. This species has suffered a sudden and rapid population decline due to which it has been listed as critically endangered.
- Habitat: Fallow fields and scrub desert.
- Distribution: central Asia, Asia Minor, Russia, Egypt, India, Pakistan. In India, habitat / distribution is restricted to the north and north-west of the country.
- Threats: Conversion of habitat to arable land, illegal hunting and proximity to human settlements.

12.4.8. Spoon Billed Sandpiper

- It requires highly specialized breeding habitat, a constraint that has always kept its population scarce. India is home to some of the last existing wintering grounds of this species.
- Habitat: Coastal areas with sparse vegetation. No breeding records further inland than 7 km from the seashore.
- Distribution: Has been recorded in West Bengal, Orissa, Kerala and Tamil Nadu.
- Threats: Habitat degradation and land reclamation. Human disturbance also leads to high incidence of nest desertion.

12.4.9. Siberian Crane

- It is a large, strikingly majestic migratory bird that breeds and winters in wetlands. They are known to winter at Keoladeo National Park, Rajasthan. However the last documented sighting of the bird was in 2002.
- Habitat: Wetland areas.
- Located distribution: Keoladeo National Park in Rajasthan.
- Threats: Pesticide pollution, wetland drainage, development of prime habitat into agricultural fields, and to some extent, hunting.

Do you know?

- Hoolock Gibbon is the only ape found in India. Rest of the monkeys are all macaques and langurs. In India is distributed in the northeast India.
- Palms are typically unbranched trees with only one trunk (columnar stem), called the "caudex," which ends in a crown of large leaves.

12.5. CORALS

12.5.1. Fire corals

- They are more closely related to jellyfish than corals. On contact, one usually feels a burning sensation similar to a sting from a jellyfish.
- Habitat: Generally found in murky inshore waters and display a tolerance for siltation. They often are found in clear offshore sites.
- Distribution: Indonesia, Gulf of Chiriquí, Panama Pacific Province. Possibly extinct from Australia, India, Indonesia, Malaysia, Panama, Singapore and Thailand.
- Threats: Collected for decoration and jewellery trade. This group is also sensitive to temperature rise, and is thought to have completely disappeared from the majority of marine areas possibly because of growing global warming related bleaching effects.

12.6. BIRD'S MIGRATION

- Migration refers to the regular, recurrent and cyclical seasonal movement of birds from one place to other. The distance of migration ranged from short distance to thousands of kilometers. But at the end of period, birds will eventually return to the original place.

12.6.1. Reasons for migration

1. To avoid adverse factors (extreme climatic condition)
2. To manage food shortage
3. To manage shortage of water
4. To have a better breeding conditions
5. Less competition for safe nesting places

Are black rhinos really black?

No, black rhinos are not black at all. The species probably derives its name as a distinction from the white rhino (which is not white at all either) or from the dark-colored local soil that often covers its skin after wallowing in mud.

12.6.2. Migratory birds of India

Winter birds	Summer birds
Siberian Cranes, Greater Flamingo, Common Teal, Yellow Wagtail, White Wagtail, Northern Shoveler, Rosy Pelican, Wood Sandpiper, Spotted Sandpiper, Eurasian Pigeon, Black Tailed Godwit, Spotted Redshank Starling Bluethroat, Long Billed Pipit.	Asian Koel, Black Crowned Night Heron, Eurasian Golden Oriole, Comb Duck, Blue Cheeked Bee Eater, Blue-Tailed Bee-Eater, Cuckoos.

12.7. WILDLIFE DISEASES

Diseases	Casual organism	Animal susceptible
Tuberculosis	Mycobacterium spp	Deer, cat, primates, elephant
Anthrax	Bacillus anthraxis	Gaur, chetal, wild pig, barking deer
Rabies	Rabies virus	Tiger, lion, bear, mongoose, squirrel
Foot and mouth disease	FMD virus	Gaur, nilgai, chetal, sambar, yak, mithun
Rinder pest	Microbilli virus	Deer, wild pig, wild buffalo
Trypanosomia	Trypanosomia virus	Tiger, elephant, sambar, macaque
Taxoplasmosis	Taxoplasma gondii	Rhesus macaque, civet cat

Do you know?

All birds have feathers and feathers do many jobs for birds. It keeps them warm, wing feathers allow flight and tail feathers are used for steering. The color of the feathers can be used to hide the bird or to help the bird find a mate.

12.8. SPECIES EXTINCTION

- Extinction is caused through various processes:
    - Deterministic processes that have a cause and effect. E.g. glaciations, human interference such as deforestation.
    - Stochastic processes (chance and random events) that effect the survival and reproduction of individuals. E.g. unexpected changes of

weather patterns, decreased food supply, disease, increase of competitors, predators or parasites, etc. that may act independently or add to deterministic effects.

- The impact of these processes will of course depend on the size and degree of genetic diversity and resilience of populations.
- Traits that adversely affect or increase a species vulnerability to extinction due to habitat fragmentation have been identified. These are:
  - rarity or low abundance
  - poor dispersal ability
  - ecological specialization
  - unstable populations
  - high trophic status – as animals occupying a higher trophic level (i.e. the position of a species in a food chain) usually have smaller populations than those at lower levels (e.g. carnivores are fewer in number than herbivores)
  - low adult survival rates
  - low intrinsic rate population increase
  - Body size, fecundity, dietary specialization.

12.8.1. Natural extinctions

- Have been caused due to several factors:
  - continent drifting,
  - climate change,
  - tectonic activity
  - increased volcanic activity
  - The late Ordovician global glaciations (439 Mya).
  - The late Cretaceous extinction assumed to be associated with an extra-terrestrial impact.
- Extinction in vascular plants has been more gradual compared with the loss of animals. It is believed that extinction among this group was due more to competitive displacement by more advanced plant forms, or due to a gradual climate change, than due to any sudden catastrophic event.

12.8.2. Artificial Extinction

- Even though species extinction is a natural process which can happen without the intervention of humans, extinctions caused by humans is now happening over and above the reasonable estimate of natural extinction rates.
- Species are threatened with extinction by the intervention of humans due to:
  - direct causes – such as hunting, collection or capture and persecution
  - Indirect causes – such as habitat loss, modification and fragmentation and the introduction of invasive species.

Do you know?

One of the unique features of the Rock pythons of India is that they can raise their body temperature above the ambient level, through muscular contractions. Rock python of India is an endangered species. The reason for this is that it is killed for its fine skin, meat and even for medicinal purposes.

12.9. MAN - ANIMAL CONFLICT

- It refers to the interaction between wild animals and people and the resultant negative impact on people or their resources, or wild animals or their habitat. It occurs when wildlife needs overlap with those of human populations, creating costs to residents and wild animals.

12.9.1. Causes

- Human population growth
- Land use transformation
- Species habitat loss, degradation and fragmentation
- Increasing livestock populations and competitive exclusion of wild herbivores

- Growing interest in ecotourism and increasing access to nature reserves
- Abundance and distribution of wild prey
- Increasing wildlife population as a result of conservation programmes
- Climatic factors
- Stochastic events (e.g. fire)

12.9.2. Impacts

- Crop damage
- Livestock depredation
- Injuries to people
- Loss of human life
- Damage to property
- Injuries to wildlife
- Animal deaths
- Destruction of habitat

12.9.3. Preventive strategies

- Artificial and natural barriers (physical and biological)
- Guarding
- Alternative high-cost livestock husbandry practices
- Relocation: voluntary human population resettlement
- Waste management systems that restrict wildlife access to refuse

12.9.4. Mitigative strategies

- Compensation systems
- Insurance programmes
- Incentive programmes
- Community based natural resource management schemes (CBNRMS)
- Regulated harvest
- Increase alternate crops, preys or water points
- Wildlife translocation
- Conservation education for local populations
- Better sharing of information.

Do you know?

Black Panther is not a separate species. Blackness, the general darkening of colour is due to the excessive presence of a substance called Melanin which intensifies pigmentation. The production of melanin is increased where there is a combination of high temperature, humidity and reduced light. Both black and normal-coloured cubs may be produced in the same litter.

12.10. ADVISORY FOR MANAGEMENT OF HUMAN-WILDLIFE CONFLICT (HWC)

- The advisory makes prescriptions for the States/ Union Territories for dealing with Human-Wildlife conflict situations and seeks expedited inter-departmental coordinated actions, adoption of early warning systems, creation of barriers, dedicated circle wise Control Rooms with toll free hotline numbers, Identification of hotspots and formulation and implementation of special plans for improved stall-fed farm animal etc.
- The advisory envisages empowering gram panchayats in dealing with the problematic wild animals as per the section 11 (1) (b) of Wild Life (Protection) Act, 1972.
- Payment of a portion of ex-gratia as interim relief within 24 hours of the incident to the victim/ family.
- Utilising add-on coverage under the Pradhan Mantri Fasal Bima Yojna for crop compensation against crop damage due to HWC and augmenting fodder and water sources within the forest areas are some key steps envisaged to reduce HWC.

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CHAPTER - 13

PLANT DIVERSITY OF INDIA

13.1. PLANT CLASSIFICATION

1. Herb is defined as a plant whose stem is always green and tender with height of not more than 1 meter.
2. Shrub is defined as a woody perennial plant differing from a perennial herb in its persistent and woody stem. It differs from a tree in its low stature and its habit of branching from the base. Not more than 6 meters in height.
3. Tree is defined as a large woody perennial plant having a single well defined stem with more or less definite crown.
4. Parasites - An organism that draws a part or whole of its nourishment from another living organism. These plants do not draw moisture and mineral nutrients from the soil. They grow on some living plant called host and penetrate their sucking roots, called haustoria, into the host plants.
    - Total parasite - draws whole of its nourishment
    - Partial parasite - draws a part of its nourishment
5. Epiphytes - plant growing on the host plant but not nourished by the host plant. They do not draw food from the host plant. They only take the help of the host plant in getting access to light. Their roots perform two functions. While changing roots establish the plant on the branches of the host plant, aerial roots draw moisture from the air. Eg. Vanda
6. Climbers - herbaceous or woody plant that climbs up trees or other support by twining round them or by holding on to them by trendrills, hooks, aerial roots or other attachments.

Do you know?

Kannimara teak is one of the largest living teak tree in the world. It has an amazing girth of 6.48m and a crown height of 48.75m It is believed to be around 400 years old.

According to the local tribal belief here when this tree was tried to cut down, the blood spurted out from the place of cut. This tree was being since then worshipped by the local tribes in Parambikulam as "Virgin tree". Kannimara - ' Kanni' means 'Virgin'. This tree has been awarded 'Mahavriksha Puraskar' by the Government of India.

13.2. EFFECT OF ABIOTIC COMPONENTS ON PLANTS

13.2.1. Intensity of light on growth of plants

- Extremely high intensity favours root growth than shoot growth which results in increased transpiration, short stem, smaller thicker leaves. On the other hand low intensity of light retards growth, flowering and fruiting.
- When the Intensity of light is less than the minimum, the plants ceases to grow due to accumulation of CO2 and finally dies.

- Out of 7 colours in the visible part of spectrum, only red and blue are effective in photosynthesis.
- Plant grown in blue light are small, red light results in elongation of cells results in etiolated plants. Plants grown in ultraviolet and violet light are dwarf.

13.2.2. Effect of frost on plants

- Killing of young plants - Even a light radiation frost chills the soil resulting in freezing the soil moisture. The plants growing in such soil, get exposed to direct sun light in the morning, they are killed due to increased transpiration when their roots are unable to supply moisture. This is the main reason for innumerable death of sal seedlings.
- Death of plants due to damage to cells - As a result of frost, water in the intercellular spaces of the plant gets frozen into ice which withdraws water from the interior of the cells. This results in increasing concentration of salts and dehydration of cells. Thus coagulation and precipitation of the cell colloid results in death of plant.
- Leads to Formation of canker.

Do you know?

- No tree dies of old age. They are generally killed by insects, disease or by people.
- Trees grow from the top, not from the bottom as is commonly believed.
- Tree leaves help trap and remove tiny particles of soot and dust which otherwise damages human lungs.
- Tree root networks filter contaminants in soils producing clean water.
- Trees prevent erosion by trapping soil that would otherwise become silt

13.2.3. Effects of Snow on plants

- Snow influences the distribution of deodar, fir and spruce.
- Snow acts as blanket, prevents further drop in temperature and protects seedlings from excessive cold and frost.
- It results in mechanical bending of tree stem.
- Shortens the period of vegetative growth also uproots the trees.

13.2.4. Effect of temperature on plants

- Excessive high temperature results in death of plant due to coagulation of protoplasmic proteins. It disturbs the balance between respiration and photo synthesis thereby causes depletion of food resulting in greater susceptibility to fungal and bacterial attack.
- It also results in desiccation of plant tissues and depletion of moisture.

13.2.5. Die back

Refers the progressive dying usually backwards from the tip of any portion of plant. This is one of the adaptive mechanisms to avoid adverse conditions. In this mechanism, the root remains alive for years together but the shoots dies. Eg. Sal, Red sanders, Terminalia tomentosa, Silk cotton tree, Boswellia serrata.

Causes for die back

1. Dense over head canopy and inadequate light
2. Dense week growth
3. Un-decomposed leaf litter on surface
4. Frost
5. Drip
6. Drought

Do you know?

- Tree rings provide precise information about environmental events, including volcanic eruptions.

13.3. INSECTIVOROUS PLANTS

These plants are specialised in trapping insects and are popularly known as insectivorous plants.

They are very different from normal plants in their mode of nutrition. They, however, never prey upon humans or large animals as often depicted in fiction.

Insectivorous plants can broadly be divided into active and passive types based on their method of trapping their prey.

- The active ones can close their leaf traps the moment insects land on them.
- The passive plants have a 'pitfall' mechanism, having some kind of jar or pitcher-like structure into which the insect slips and falls, to eventually be digested.

The insectivorous plants often have several attractions such as brilliant colours, sweet secretions and other curios to lure their innocent victims.

Why do they hunt despite having normal roots and photosynthetic leaves?

These plants are usually associated with rain-washed, nutrient-poor soils, or wet and acidic areas that are ill-drained. Such wetlands are acidic due to anaerobic conditions, which cause partial decomposition of organic matter releasing acidic compounds into the surroundings. As a result, most microorganisms necessary for complete decomposition of organic matter cannot survive in such poorly oxygenated conditions.

Normal plants find it difficult to survive in such nutrient poor habitats. The hunter plants are successful in such places because they supplement their photosynthetic food production by trapping insects and digesting their nitrogen rich bodies.

13.3.1. Insectivorous plants of India

The Indian Hunters

1. **Drosera or Sundew** inhabiting wet infertile soils or marshy places

- Insect trapping mechanism: The tentacles on the leaves secrete a sticky fluid that shines in the sun like dew-drops. Therefore the Drosera. are commonly known as 'sundews'. When an insect lured by these glistening drops alights on the leaf surface it gets stuck in this fluid and are absorbed and digested.

2. **Aldrovanda** is a freefloating, rootless aquatic plant, the only species found in India, occurs in the salt marshes of Sunderbans, south of Calcutta. It also grows in fresh water bodies like ponds, tanks and lakes.

- **Insect trapping mechanism:** On the leaf midrib are found some sensitive trigger hairs. The two halves of the leaf blade of Aldrovanda close along the midrib the moment an insect comes into contact with the leaf, trapping the victim inside.

3. **Nepenthes: The members of the family are commonly known as 'pitcher plants' because their leaves bear jar-like structures.**

- Distribution - It is confined to the high rainfall hills and plateaus of north-eastern region, at altitudes ranging from 100 – 1500 m, particularly in Garo, Khasi and Jaintia hills of Meghalaya.
- Insect trapping mechanism: Nepenthes conforms to the pitfall type of trap. A honey like substance is secreted from glands at the entrance of the pitcher. Once the insect enters into the pitcher, it falls down because of the slipperiness.
- The inner wall, towards its lower half, bears numerous glands, which secrete a proteolytic enzyme. This enzyme digests the body of the trapped insects and nutrients are absorbed.

4. **Utricularia or Bladderworts:** The Bladderworts generally inhabit freshwater wetlands and waterlogged areas. Some species are associated with moist moss covered rock surfaces, and damp soils during rains.

- Insect trapping: Utricularia in its bladders mouth, has sensitive bristles or hairs. When an insect happens to contact these hairs the door opens, carrying the insect into the bladder along with a little current of water. The door is shut when water fills the bladder, The enzymes produced by the inner wall of the bladder digest the insect.

5. **Pinguicula or Butterwort:** It grows in the alpine heights of Himalayas, from Kashmir to Sikkim, along stream-sides in cool boggy places.

- Insect trapping mechanism: In Pinguicula, an entire leaf works as trap. When an insect lands on the leaf surface, it gets stuck in the sticky exudate. the leaf margins roll up thus trapping the victim.

13.3.2. Medicinal properties

Drosera are capable of curdling milk, its bruised leaves are applied on blisters, used for dyeing silk.

Nepenthes in local medicine to treat cholera patients, the liquid inside the pitcher is useful for urinary troubles, it is also used as eye drops.

Utricularia is useful against cough, for dressing of wounds, as a remedy for urinary disease.

Do you know?

The seeds of Phytelephas macrocarpa, in the family Arecaceae, commonly called "ivory nut" or "tagua palm tree," is the chief source of vegetable ivory. It is extensively used as a substitute for true ivory. It can be carved and used in the manufacture of buttons, chess pieces, poker chips, dice, knobs, inlays, billiard balls, toys, etc. Metroxylon amicarum, in the Arecaceae family, can likewise be used for these purposes

13.3.3. Threat

- Gardening trading for medicinal properties is one of the main causes for their decline.
- Habitat destruction is also rampant, the wetlands harbouring such plants being the main casualties during the expansion of urban and rural habitation.
- Pollution caused by effluents containing detergents, fertilizers, pesticides, sewage etc into the wetlands is yet another major cause for their decline (Since insectivorous plants do not tolerate high nutrient levels)
- Moreover, polluted water bodies are dominated by prolific water weeds which cause elimination of the delicate insectivorous plants.

Do you know?

A flowering tree usually has a dome-shaped appearance and a deliquescent stem in which the main trunk divides at some distance from the ground into several branches, which branch again and again, making the trunk appear to deliquese or melt away

13.4. INVASIVE ALIEN SPECIES

Purposely or accidentally, people often bring non-native species into new areas where the species have few or no natural predators to keep their populations in check.

Aliens are species that occur outside their natural range. Alien species that threaten native plants and animals or other aspects of biodiversity are called alien invasive species. They occur in all groups of plants and animals, as competitors, predators, pathogens and parasites, and they have invaded almost every type of native ecosystem,

Biological invasion by alien species is recognised as one of the major threats to native species and ecosystems. The effects on biodiversity are enormous and often irreversible.

13.4.1. Invasion and Species Richness

The invasions potentially lead to an increase in species richness, as invasive species are added to the existing species pool. But it also leads to extinction of native species, resulting in decrease of species richness. The negative interactions are primarily the competition with natives for food and sustenance, which may not allow coexistence and also by predation.

13.4.2. Effects

- Loss of Biodiversity
- Decline of Native Species (Endemics).
- Habitat Loss

- Introduced pathogens reduce crop and stock yields
- Degradation of marine and freshwater ecosystems

This biological invasion constitutes the greatest threat to biodiversity, and it has already had devastating consequences for the planet and challenges for the conservation managers.

13.4.3. Invasive fauna in India

A new invasive gall forming insect of Eucalyptus in Southern India.

- Leptocybe invasa - a new insect pest detected from few pockets of coastal Tamil Nadu and it has spread to peninsular India.
- It is a tiny wasp that forms leaf and stem galls in Eucalyptus.

Other invasive fauna in India are Crazy ant, Giant African snail, Myna, Gold Fish, Pigeon, Donkey, House Gecko, Tilapia.

Do you know?

1. Roots store more starch than the trunk.
2. Roots do not have a central pith (soft central tissue) while the trunk does.
3. The majority of tree roots are non-woody. These non-woody roots only live for a few weeks.
4. The root hairs grow within days, when water, temperature, and nutrients are available to promote growth.

13.5. INVASIVE ALIEN FLORA OF INDIA

13.5.1. Needle Bush

- Nativity: Trop. South America
- Distribution in India: Throughout
- Remarks: Occasional in thorny scrub and dry degraded forests and often creates close thickets.

13.5.2. Black Wattle

- Nativity: South East Australia
- Distribution in India: Western Ghats
- Remarks: Introduced for afforestation in Western Ghats. Regenerates rapidly after fire and forms dense thickets. It is distributed in forests and grazing lands in high altitude areas.

13.5.3. Goat weed

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Troublesome weed in gardens, cultivated fields and forests.

13.5.4. Alternanthera paronychioides

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Occasional weed along edges of tanks, ditches and in marshy lands.

13.5.5. Prickly Poppy

- Nativity: Trop. Central & South America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common winter season weed in cultivated fields, scrub lands and fringes of forests.

13.5.6. Blumea eriantha

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Abundant along railway tracks, road sides and degraded forest lands.

13.5.7. Palmyra, Toddy Palm

- Nativity: Trop. Africa
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Cultivated and self sown, occasionally found to be gregarious near by cultivated fields, scrub lands and waste lands.

13.5.8. Calotropis / Madar, Swallo Wort

- Nativity: Trop. Africa
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common in cultivated fields, scrub lands and waste lands.

13.5.9. Datura, Mad Plant, Thorn Apple

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Occasional weed on disturbed ground.

> **Do you know?**
>
> Some trees can "talk" to each other. When willows are attacked by webworms and caterpillars, they emit a chemical that alerts nearby willow of the danger. The neighboring trees then respond by pumping more tannin into their leaves making it difficult for the insects to digest the leaves.

13.5.10. Water Hyacinth

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Abundant in still or slow floating waters. Nuisance for aquatic ecosystems.

13.5.11. Impatiens, Balsam

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common along streams of moist forests and occasionally along railway tracks; also runs wild in gardens.

13.5.12. Ipomoea / the pink morning glory

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of marhsy lands and along the edges of tanks and ditches.

13.5.13. Lantana camara / Lantana, Wild Sage

- Nativity: Trop. America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of forests, plantations, habitation, waste lands and scrub lands.

13.5.14. Black Mimosa

- Nativity: Trop. North America
- Distribution in India: Himalaya, Western Ghats
- Remarks: Aggressive colonizer. It invades water courses and seasonally flooded wetlands.

13.5.15. Touch-Me-Not, Sleeping Grass

- Nativity: Brazil
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of cultivated fields, scrub lands and degraded forests.

13.5.16. 4 'o' clock plant.

- Nativity: Peru
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Runs wild in gardens and near habitation.

13.5.17. Parthenium / Congress grass, Parthenium

- Nativity: Trop. North America
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of cultivated fields, forests, overgrazed pastures, waste lands and gardens.

13.5.18. Prosopis juliflora / Mesquite

- Nativity: Mexico
- Distribution in India: Throughout
- Remarks: Aggressive colonizer. Common weed of waste lands, scrub lands and degraded forests.

13.5.19. Townsend grass

- Nativity: Trop. W. Asia
- Distribution in India: Throughout
- Remarks: Very common along streams and banks of rivers.

> **Do you know?**
>
> The world's tallest tree is a coast redwood in California, measuring more than 360 ft or 110 m.

13.6. MEDICINAL PLANTS

13.6.1. Beddomes Cycad / Perita / Kondaitha

- Eastern Peninsular India.
- Uses: The male cones of the plant are used by local herbalists as a cure for rheumatoid arthritis and muscle pains. Fire resistant property is also there.

13.6.2. Blue vanda / Autumn Ladies Tresses Orchid

- Distribution: Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland.
- Vanda is one of the few botanical orchids with blue flowers a property much appreciated for producing interspecific and intergeneric hybrids.

13.6.3. Kuth / Kustha / Pooshkarmoola / Uplet

- Distribution: Kashmir, Himachal Pradesh
- Uses: It is used as an anti-inflammatory drug, and a component of the traditional Tibetan medicine. The roots of the plant are used in perfumery. Dry roots (Kuth, Costus) are strongly scented and yields an aromatic oil, which is also used in making insecticides. The roots contain an alkaloid, 'saussurine', which is medicinally important.

13.6.4. Ladies Slipper Orchid

- Uses: These types of orchids are mainly used as collector's items but lady's slipper is some times used today either alone or as a component of formulas intended to produce treat anxiety / insomnia (scientific evidence is not present). This is also sometimes used topically as a poultice or plaster for relief of muscular pain.

13.6.5. Red vanda

- Distribution: Manipur, Assam, Andhrapradesh
- Uses: As a whole orchids are collected to satisfy an ever demanding market of orchid fanciers, especially in Europe, North America and Asia.

13.6.6. Sarpagandha

- Distribution: Sub Himalayan tract from Punjab eastwards to Nepal, Sikkim, Assam, Eastern & Western Ghats, parts of Central India & in the Andamans.
- Uses: Rauvolfia roots are of immense medicinal value and has steady demand. It is used for treating various central nervous system disorders. The pharmacological activity of rauvolfia is due to the presence of several alkaloids of which reserpine is the most important, which is used for its sedative action in mild anxiety states and chronic psychoses. It has a depressant action on central nervous system produces sedation and lower blood pressure. The root extracts are used for treating intestinal disorders, particularly diarrhoea and dysentery and also anthelmintic. It is used for the treatment of cholera, colic and fever. The juice of the leaves are used as a remedy for opacity of the cornea. The total root extracts exhibits a variety of effects, viz., sedation, hypertension, brodyeardia, myosis, ptosis, tremors, which are typical of reserpine.

13.6.7. Ceropegia species.

- Lantern Flower, Parasol Flower, Parachute Flower, Bushman's Pipe.
- Uses: These plants are used as ornamental plants.

13.6.8. Emodi / Indian Podophyllum

- Himalayan May Apple, India May Apple etc.,
- Distribution: Lower elevations in and around surrounding the Himalayas.
- Uses: Rhizomes and roots constitute the drug. The dried rhizome form the source of medicinal resin. Podophyllin is toxic and strongly irritant to skin and mucous membranes.

13.6.9. Tree Ferns

- Distribution: Lower elevations in and surrounding the Himalaya.
- Uses: The Soft Tree Fern can be used as a food source, with the pith of the plant being eaten either cooked or raw. It is a good source of starch.

13.6.10. Cycads

- A Gymnosperm tree.
- All known as living fossil.
- Distribution: Western ghats, Eastern ghats, North East India and Andaman and Nicobar Islands.
- Cycads have been used as a source of starch and also during socio-cultural rituals.
- There is some indication that the regular consumption of starch derived from cycads is a factor in the development of Lytico-Bodig disease, a neurological disease with symptoms similar to those of Parkinson's disease and ALS.
- Threats: Over harvesting, Deforestation and forest fire.

13.6.11. Elephant's foot

- Distribution: Throughout the North Western Himalayas.
- Uses: Commercial source of Diosgenin (a steroid sapogenin, is the product of sapogenin, is the product of hydrolysis by acids, strong bases, or enzymes of saponins, extracted from the tubers of Dioscorea wild yam. The sugar-free (aglycone), diosgenin is used for the commercial synthesis of cortisone, pregnenolone, progesterone, and other steroid products).

Do you know?

The world's oldest trees are 4,600 year old Bristlecone pines in U.S.A.

13.7. TREE CHARACTERS

13.7.1. Types of Trees:

There are two main types of trees: deciduous and evergreen.

(i) Deciduous trees

- lose all their leaves for part of the year.
- In cold climates, this happens during the autumn so that the trees are bare throughout the winter.
- In hot and dry climates, deciduous trees usually lose their leaves during the dry season.

(ii) Evergreen trees

- don't lose all their leaves at the any time (they always have some foliage).
- They do lose their old leaves a little at a time with new ones growing in to replace the old. An evergreen tree is never completely without leaves.

Trees

T - Timber, the first and the foremost use of trees

R - Restoration, reclamation and rejuvenation of denuded and disturbed soils by using trees to control soil erosion and desertification, protect watersheds, improve soil nutrient status (by growing nitrogen-fixing trees) and retain moisture in the soil

E - Ecological, eco-developmental and environmental use of trees for effective and efficient purification of the environment because trees act as oxygen banks and eliminate air pollutants; for abating or moderating temperature, noise and wind by planting trees as environmental screens, thus affecting the microclimate; for harboring wildlife; for maintaining biodiversity; and for conserving energy

E - Educational and recreational value in gardening, landscaping, art, culture and religion

S - Source of sustenance; i.e., food, fuel, fodder, fertilizer, fiber, medicine, tannin, dyes, oils, etc.

13.7.2. Parts of a Tree:

Roots:

- The roots are the part of the tree that grows underground.
- Besides keeping the tree from tipping over, the main job of the roots is to collect water and nutrients from the soil and to store them for times when there isn't as much available.

Crown:

- The crown is made up of the leaves and branches at the top of a tree.
- The crown shades the roots, collects energy from the sun (photosynthesis) and allows the tree to remove extra water to keep it cool (transpiration -- similar to sweating in animals).

Do you know?

1. Trees are the largest and oldest living organism on earth:
2. It can take 10 minutes to walk around the crown of a giant banyan tree in Calcutta.
3. Trees trap more of the sun's energy than any other group of organisms on earth
4. Trees do not restore and repair wood that is injured and infected, instead they compartmentalize off the damaged tissue.

Leaves:

- They are the part of the tree that converts energy into food (sugar).
- Leaves are the food factories of a tree.
- They contain a very special substance called chlorophyll. It is chlorophyll that gives leaves their green colour.
- Chlorophyll is an extremely important biomolecule, used in photosynthesis. leaves use the sun's energy to convert carbon dioxide from the atmosphere and water from the soil into sugar and oxygen.
- The sugar, which is the tree's food, is either used or stored in the branches, trunk and roots. The oxygen is released back into the atmosphere.

Branches:

- The branches provide the support to distribute the leaves efficiently for the type of tree and the environment.
- They also serve as conduits for water and nutrients and as storage for extra sugar.

Trunk:

- The trunk of the tree provides its shape and support and holds up the crown.
- The trunk transports water and nutrients from the soil and sugar from the leaves.

13.7.3. Parts of the Trunk:

Annual rings

- Inside the trunk of a tree there are a number of growth rings.
- Each year of the tree's life, a new ring is added so it is referred as the annual rings.
- It is used to calculate Dendro-Chronology (Age of a tree) and Paleo-Climatology.
- The age of a tree can be determined by the number of growth rings. The size of the growth ring is determined in part by environmental conditions - temperature, water availability.

Bark:

- The outside layer of the trunk, branches and twigs of trees.
- The bark serves as a protective layer of the tree.
- Trees actually have inner bark and outer bark. The inner layer of bark is made up of living cells and the outer layer is made of dead cells, sort of like our fingernails.
- The scientific name for the inner layer of bark is Phloem. The main job of this inner layer is to carry sap full of sugar from the leaves to the rest of the tree.
- A number of handy things are made from bark including latex, cinnamon and some kinds of poisons. It isn't surprising the strong flavours, scents and toxins can often be found in the bark of different types of trees.

Cambium:

- The thin layer of living cells just inside the bark is called cambium.
- It is the part of the tree that makes new cells allowing the tree to grow wider each year.

Sapwood (Xylem):

- The scientific name for sapwood is xylem.
- It is made up of a network of living cells that bring water and nutrients up from the roots to the branches, twigs and leaves.
- It is the youngest wood of the tree -- over the years, the inner layers of sapwood die and become heartwood.

Heartwood:

- The heartwood is dead sapwood in the center of the trunk.
- It is the hardest wood of the tree giving it support and strength.
- It is usually darker in colour than the sapwood.

Pith:

- Pith is the tiny dark spot of spongy living cells right in the center of the tree trunk.
- Essential nutrients are carried up through the pith.
- It's placement right in the center means it is the most protected from damage by insects, the wind or animals.

13.7.4. Root types

- Taproot - Primary descending root formed by the direct prolongation of the radicle of the embryo.
- Lateral Root - Roots that arise from the tap root and spread laterally to support the tree.
- Adventitious Roots - Roots that are produced from the parts of the plant other than the radicle or its subdivision. The following kinds of Adventitious Roots are commonly found in trees.
- Buttresses - They are out - growths formed usually vertically above the lateral roots and thus connect the base of the stem with roots. They are formed in the basal portion of the stem.
  - Ex: Silk cotton tree.
- Prop - Roots - Adventitious Roots - produced from the branches of the tree which remain suspended in the air till they reach the ground. On reaching the ground they enter into the soil and get fixed.
  - Ex: Banyan Tree
- Stilt - Roots - Adventitious Roots which emerged from the butt of a tree above ground level. So that the tree appears as if supported on flying buttresses.
  - Ex: Rhizphora species of mangroves.
- Pneumatophore: It is a spike like projection of the roots of swamp / mangrove tree above the ground. It helps the submerged roots to obtain oxygen.
  - Ex: Heretiera spp, Bruguiera spp.
- Haustorial roots are the roots of parasitic plants that can absorb water and nutrients from another plant.
  - Eg: mistletoe (Viscum alubum) and dodder.
- Storage roots are modified roots for storage of food or water, such as carrots and beets. They include some taproots and tuberous roots.
- Mycorrhiza - structure produced from the combination of the modified rootlet with fungal tissue.

Do you know?

1. A tree can absorb as much as 48 pounds of carbon dioxide per year and can sequester 1 ton of carbon dioxide by the time it reaches 40 years old.
2. Tree wood is a highly organized arrangement of living, dying, and dead cells.

13.7.5. Canopy classification–

- Relative completeness of canopy. Classified into 4 types.
  - Closed - the density is 1.0
  - Dense - the density is 0.75 to 1.0
  - Thin - the density is 0.50 to 0.75
  - Open - the density is under 0.50

13.7.6. Other characters

- Phenology - Science that deals with the time of appearance of characteristic periodic events such as leaf shedding etc.
- Etiolation - With the absence of adequate light, plants become pale yellow and have long thin internodes.
- Autumn tints - in some trees, leaves undergo a striking change in colour before falling from the tree.
    - Ex: Mango, Cassia fistula, Quercus incana
- Taper - the decrease in diametre of the stem of a tree from the base upwards. i.e., the stem is thicker at the base and thinner in the upper portion of the tree.
- Tapering occurs due to the pressure of the wind which is centred in the lower one third of the crown and is conveyed to the lower parts of the stem, increasing with increasing length. To counteract this pressure, which may snap the tree at the base, the tree reinforces itself towards the base.
- They are generally associated with the absence of long taproot system due to either shallow soil are badly aerated and infertile subsoil.
- Bamboo gregarious flowering - general flowering over the considerable area of all (or) most of the individuals of certain species, that do not flower annually. Generally followed by death of a plant.
- Sal Tree grows in variety of geological formations but completely absent in Deccan trap where its place is taken by teak.
- Sandal tree is a partial-root parasite. The seedlings of this species grow independently in the beginning but in few months develop haustorial connections with the roots of some shrub and later with some tree species growing in the vicinity. Sandle tree manufactures its own food but depends upon the host like other partial parasites for water and mineral nutrients.
- Aerial seeding is the process of dispersing the seed aerially. In India, aerial seeding has been done on experiment basis in Chambal ravines in UP, Rajasthan, West Bengal and Western Ghats of Maharashtra. The research carried out during 1982 shows that the survival percentage was 97.3 and 2.7 for Prosopis juliflora and Acacia nilotica respectively. The survey indicated that 25% of the area has not responded for aerial seeding at all.

CHAPTER - 14

MARINE ORGANISMS

14.1 PLANKTON

- The term 'plankton' refers to the group of organisms which float in the surface waters of the rivers, lakes and oceans.
- Includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton) found in all aquatic ecosystems, except certain swift moving waters.
- The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems.
  - The growth rate, productivity and species diversity of plankton in tropical waters especially in mangrove waters are high.

14.2 PHYTOPLANKTON

- Derived from the Greek words phyto (plant) and plankton (made to wander or drift), phytoplankton are microscopic plant organisms that live in aquatic environments, both salty and fresh.
- Some phytoplankton are bacteria, some are protists, and most are single-celled plants. Among the common kinds are cyanobacteria, silica-encased diatoms, dinoflagellates, green algae, and chalk-coated coccolithophores.
- Phytoplankton produce more than 60% of oxygen produced from all plants.
- Like land plants, all phytoplankton have chlorophyll to capture sunlight, and they use photosynthesis to turn it into chemical energy. They consume carbon dioxide, and release oxygen. All phytoplankton photosynthesize, but some get additional energy by consuming other organisms.
- These micro-algae are present throughout the lighted regions of all the seas and oceans including the Polar Regions.
- Their total biomass is many times greater than that of the total plants on land and they serve as the "pasture grounds" in the aquatic environment.

> **Do you know?**
>
> Sea Kraits are one of the few sea snakes that go to land to lay their eggs while most others, like the Olive sea snake will give birth in the water.

14.2.1. Factors Affecting Phytoplanktons Biodiversity

Light

- Phytoplanktons are limited to the uppermost layers of the ocean where light intensity is sufficient for photosynthesis to take place.
- The photosynthetic rate varies with light intensity.

Nutrients

- The major inorganic nutrients required by phytoplankton for growth and reproduction are nitrogen and phosphorus.
- Diatoms and silicoflagellates also require silicate (SiO_2) in significant amounts.

- Some phytoplankton can fix nitrogen and can grow in areas where nitrate concentrations are low.
- They also require trace amounts of iron which limits phytoplankton growth in large areas of the ocean because iron concentrations are very low.

Temperature

- Temperature acts along with other factors in influencing the variation of photosynthetic production.
- Generally, the rate of photosynthesis increases with an increase in temperature, but diminishes sharply after a point is reached.
- Temperature, together with illumination, influences the seasonal variation of phytoplankton production in the temperate latitudes.

Salinity

- Besides light and temperature, salinity also is known to influence primary production.

Grazing by Zooplankton

- The grazing rate of zooplankton is one of the major factors influencing the size of the standing crop of phytoplankton, and thereby the rate of production.

Distribution

- Marine phytoplankton are not uniformly distributed throughout the oceans of the world. The highest concentrations are found at high latitudes, with the exception of upwelling areas on the continental shelves, while the tropics and subtropics have 10 to 100 times lower concentrations.
- In addition to nutrients, temperature, salinity and light availability; the high levels of exposure to solar UV-B radiation that normally occur within the tropics and subtropics may play a role in phytoplankton distributions.
- Phytoplankton productivity is limited to the euphotic zone, the upper layer of the water column in which there is sufficient sunlight to support net productivity.
- The position of the organisms in the euphotic zone is influenced by the action of wind and waves.

14.2.2. Importance of phytoplankton

The food web

- Phytoplanktons are the foundation of the aquatic food web, the primary producers, it feeds everything from microscopic animal-like zooplankton to whales. Small fish and invertebrates graze on the phytoplanktons, and then those smaller animals are eaten by bigger ones.

Do you know?

sea snakes are usually found in shallow waters of the Indian Ocean, and warmer areas of the Pacific Ocean. They eat fish, fish eggs and eels.

The Carbon Cycle and climate change

- Phytoplankton are responsible for most of the transfer of carbon dioxide from the atmosphere to the ocean. Carbon dioxide is consumed during photosynthesis, and the carbon is incorporated in the phytoplankton, just as carbon is stored in the wood and leaves of a tree. Most of the carbon is returned to near-surface waters when phytoplankton are eaten or decompose, but some falls into the ocean depths.
- Worldwide, this "biological carbon pump" transfers about 10 gigatonnes of carbon from the atmosphere to the deep ocean each year. Even small changes in the growth of phytoplankton may affect atmospheric carbon dioxide concentrations, which would feed back to global surface temperatures.

Do you know?

1. Sharks have a sensory organ called the "ampullae of Lorenzini" which they use to "feel" the electrical field coming from its prey.
2. Silverfish is an insect that can be found in old unused books

14.3. ZOOPLANKTON

- Zooplankton play vital role in food web of the food chain, nutrient recycling, and in transfer of organic matter from primary producers to secondary consumers like fishes.
- They are more abundant within mangrove waterways than in adjacent coastal waters, and a large proportion of the juvenile fish of mangrove habitat are zooplanktivorous.
- The zooplankton determine the quantum of fish stock. Hence, zooplankton communities, based on their quality and species diversity, are used for assessing the productivity vis-à- vis fishery resource, fertility and health status of the ecosystem.
- Tiny flagellates, giant jellyfish (>50 µm).

14.4. SEA-GRASS

- Sea grasses are (angiosperms) marine flowering plants that resemble grass in appearance.
- They produce flowers; have strap-like or oval leaves and a root system.
- They grow in shallow coastal waters with sandy or muddy bottoms & require comparatively calm areas.
- They are the only group of higher plants adapted to life in the salt water.
- Major Sea grass meadows in India occur along the south east coast of Tamil Nadu and in the lagoons of a few Lakshadweep Islands. There are few grass beds around Andaman and Nicobar islands also.
- The rich growth of seagrasses along the Tamil Nadu coast and Lakshadweep islands is mainly due to high salinity, clarity of the water and sandy substratum.

14.4.1. Functions

1. Sea grass beds physically help
    - to reduce wave and current energy,
    - to filter suspended sediments from the water and
    - stabilise bottom sediments to control erosion.
2. Provides habitat for marine invertebrates and fishes.
3. Seagrass beds are widespread in lagoon & in such areas, the population of fish and migratory birds are also higher due to the availability of food and shelter.
4. Sea grasses on reef flats and near estuaries are also nutrient sinks, buffering or filtering nutrient and chemical inputs to the marine environment.

Do you know?

The five species of turtle that nest on Indian coast are Leatherback sea turtle, Green turtle, the Olive Ridley, the Hawksbill, and the Loggerhead turtle.

- IUCN has accorded high priority for the conservation of sea grass.
- Out of 58 species found in the world, Fourteen species of seagrasses have been recorded from Indian coast.
- They are commonly distributed from inter-tidal to sub-tidal region down to 8 m depth.
- Dugong, a mammal dependent on sea grass for food, is also on the verge of extinction.

14.4.2. Threats to sea grass beds

- Eutrophication, siltation, trawling, coastal engineering constructions and over exploitation for commercial purposes are the major threats for sea grass beds.

14.4.3. Management

- The major seagrass beds should be mapped and areas has to be identified for preservation.
- Dredging should be carried out far away from seagrass beds as siltation /turbidity destroys seagrass beds.

14.5. SEAWEEDS

- Seaweeds are (thalloid plants) macroscopic algae, which mean they have no differentiation of true tissues such as roots, stems and leaves. They have leaf-like appendages.

- Seaweeds, the larger and visible marine plants are found attached to rocks, corals and other submerged strata in the intertidal and shallow sub tidal zones of the sea.
- Seaweeds grow in shallow coastal waters wherever sizable substata is available.
- Based on the colour of their pigmentation, sea weeds are broadly classified into different classes such as
  - blue- green,
  - green,
  - brown,
  - red etc.

14.5.1. Functions of seaweeds

- Food for marine organism,
- habitat for fish breeding grounds,
- Source of sediment.

14.5.2. Uses of seaweeds

- Seaweeds are important as food for humans, feed for animals, and fertilizer for plants.
- Seaweeds are used as a drug for goiter treatment, intestinal and stomach disorders.
- Products like agar-agar and alginates, iodine which are of commercial value, are extracted from seaweeds.
- By the biodegradation of seaweeds methane like economically important gases can be produced in large quantities.
- Extracts of some seaweed species show antibacterial activity.
- Seaweeds are also used as the potential indicators of pollution in coastal ecosystem, particularly heavy metal pollution due to their ability to bind and accumulate metals strongly.

14.5.3. Harmful effects of seaweeds

- Rotting seaweed is a potent source of hydrogen sulfide, a highly toxic gas, and has been implicated in some incidents of apparent hydrogen-sulphide poisoning. It can cause vomiting and diarrhoea.

14.5.4. Threats to seaweeds

- Threats are similar to that of sea grass.

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CHAPTER - 15

PROTECTED AREA NETWORK

15.1. WILD LIFE PROTECTION ACT 1972

- India is the first country in the world to have made provisions for the protection and conservation of environment in its constitution. On 5th June 1972, environment was first discussed as an item of international agenda in the U.N. Conference of Human Environment in Stockholm and thereafter 5th June is celebrated all over the world as World Environment Day.
- Soon after the Stockholm Conference our country took substantive legislative steps for environmental protection. The Wildlife (Protection) Act was passed in 1972, followed by the Water (Prevention and Control of Pollution) Act 1974, the Forest (Conservation) Act, 1980, Air (Prevention and Control of Pollution) Act, 1981 and subsequently the Environment (Protection) Act, 1986.

15.1.1. Constitutional Provisions

- The provisions for environmental protection in the constitution were made within four years of Stockholm Conference, in 1976, though the 42nd amendment as follows:
- Article-48-A of the constitution provides:
- "The state shall endeavour to protect and improve the environment and to safeguard forest and wildlife of the country."
- Article 51-A (g) Provides:
- It shall be duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife an to have compassion for living creatures."
- Thus our constitution includes environmental protection and conservation as one of our fundamental duties. Some of the important Acts passed by the Government of India are discussed here.

15.1.2. The Wildlife (Protection) Act of 1972

- The passing of the Wildlife Act of 1972 constitutes an important landmark in the history of wildlife legislation in the country.
- This is because of the fact that the "Forest" including "Wildlife" was then a State subject falling in Entry 20 List II of Seventh Schedule, Parliament had no power to make law on the same except as provided in Articles 249,250 and 252 of the constitution.
- Having regard to the importance of the matter, the Act has been adopted by all the States except that of Jammu and Kashmir which has a similar law enacted for the purpose of wildlife protection. The operation of the Act is mandatory in the Union Territories too.
- The Wildlife (Protection) Act of 1972 provides the basic framework to ensure the protection and management of wildlife. The Act was amended subsequently in 1982, 1986, 1991 and 1993 to accommodate provision for its effective implementation.

The rationale for passing Act as stated in its Statement of Objects and Reasons are as follows:

- The rapid decline of India's wild animals and birds, one of the richest and most varied wildlife resources of the country has been a cause of grave concern.
- Areas which were once teeming with wildlife have become devoid of it and even in sanctuaries and National Parks the protection afforded to wildlife needs to be improved.
- The Wild Birds and Animals Protection Act, 1935 has become completely outdated.
- This existing laws not only have become outdated but also provide punishments, which are not commensurate with the offence and financial benefits that occur from poaching and trade in wildlife produce. Further, such laws mainly relate to control of hunting and do not emphasize the other factors which are also the prime reasons for the decline of India's wildlife namely taxidermy and trade in wildlife and products there from.

15.1.3. Salient features of the Act:

- The Wildlife Protection Act, 1972 is a product of process which started long ago in 1887 for the protection of a few wild birds and after addition of wild animals in 1912 and specified plants in 1919 it covered almost all the wildlife resources which need protection and management.

1. The rating of the Schedules I to V is in accordance with the risk of survival of the wildlife (fauna) enlisted in them. Animals included Schedule are provided for total protection from hunting and the trade and commerce related to such animals are strictly regulated. The schedule VI has been added to include the specified plant species to be protected by the Wildlife (Protection) Amendment Act of 1991.
2. An expert committee, constituted by the Indian Board of Wildlife considers amendments to the Act, as and when necessary.
3. With the amendment of the Act in 1991, powers of the State Governments have been withdrawn almost totally. Now the State Governments are not empowered to declare any wild animal a vermin. Further by addition of provision, immunization of livestock within a radius of 5 km from a National Park or sanctuary has been made compulsory.

15.1.4 Wildlife protection act amendment 2022

The amendment introduces several significant changes:

- A new schedule for species listed in the CITES Appendices.
- Section 6 now establishes a Standing Committee with delegated powers from the State Board for Wildlife.
- Section 43 of the act has been modified, allowing the use of elephants for religious or other purposes.
- Section 49E has been added, granting the Central Government the authority to appoint a Management Authority.
- The Central Government can now appoint a Scientific Authority for guidance on the impact on the survival of the specimens on being traded.
- The amendment grants the Central Government the power to regulate and halt the import, trade, or possession of invasive alien species.
- There has been an increase in penalties. The maximum fine for general violations has risen from 25,000 to 1 lakh, and the minimum fine for specially protected animals has increased from Rs. 10,000 to Rs. 25,000.

Do you know?

Sri Venkateshwara Zoological Park located in Tirupati city in Andhra Pradesh is the largest zoo in the country.

NATIONAL INITIATIVE

15.2. PROTECTED AREAS (PA)

- The adoption of a National Policy for Wildlife Conservation in 1970 and the enactment of the Wildlife (Protection) Act in 1972 lead to a significant growth in the protected areas network, from 5 national parks and 60 sanctuaries to a network of 669 Protected Areas with geographical area of the country, 4.92%.
- The network was further strengthened by a number of national conservation projects, notably Project Tiger, project elephant, crocodile Breeding and Management Project, etc.

15.3. WILDLIFE SANCTUARY (WLS) AND NATIONAL PARK (NP)

- The Wild Life (Protection) Act of 1972 provided for the declaration of certain areas by the State Government as wildlife sanctuaries if the area was thought to be of adequate ecological, geomorphological and natural significance.
- The Wild Life (Protection) Act (WPA) of 1972 provided for the declaration of National Parks by the State Government in addition to the declaration of wildlife sanctuaries.
- National Parks are declared in areas that are considered to be of adequate ecological, geomorphological and natural significance although within the law, the difference in conservation value of a National Park from that of a sanctuary is not specified in the WPA 1972.

Difference between the two

- National Parks enjoy a greater degree of protection than sanctuaries.
- Certain activities which are regulated in sanctuaries, such as grazing of livestock, are prohibited in National Parks.
- Wildlife sanctuary can be created for a particular species (for e.g. grizzled giant squirrel w.l.s in srivalliputhur) whereas the national park is not primarily focused on a particular species.
- The Central Government may also declare, Wild Life Sanctuary and National Park under certain conditions

15.3.1. General Provision for Sanctuary and National Park

Declaration of the Protected Area by the State Government:

- **Initial Notification:** The State Government may, by notification, declare its intention to constitute any area within or outside any reserve forest as a sanctuary/National Park if it considers that such area is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance, for the purpose of protecting, propagating or developing wild life or its environment.
- **Final notification:** After the initial notification has been issued and the period for preferring claims has elapsed, the State Government may issue a notification specifying the limits of the area which shall be comprised within the sanctuary and declare that the said area shall be a sanctuary/ National park from such date as may be specified in the notification.

Declared by the Central Government:

- The Central Government may, if it is satisfied that an area is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance, for the purpose of protecting, propagating or developing wild life or its environment, declare it a sanctuary/ National Park by notification.

Boundaries

- The notification shall specify, as nearly as possible, the situation and limits of such area.
- In cases where territorial waters is included, the limits shall be determined in consultation with the Chief Naval Hydrographer of the Central Government, after taking adequate measures to protect the occupational interests of the local fishermen.

- No alteration of boundaries of a sanctuary/ National Park shall be made except on recommendation of the National Board for Wild Life.
- (The Amendment Act of 1991 provided for the inclusion of territorial waters in areas to be declared as sanctuaries for the protection of off-shore marine flora and fauna).

Settlement of rights

- The State Government shall make alternative arrangements required for making available fuel, fodder and other forest produce to the persons affected, in terms of their rights as per the Government records.
- The State Government appoints an officer as a 'Collector' under the Act to inquire into and determine the existence, nature and extent of rights of any person in or over the land comprised within the sanctuary/ National Park which is to be notified.
- After the issue of a notification for declaration of the Protected Area, no right shall be acquired in, on or over the land comprised within the limits of the area specified in such notification, except by succession, testamentary or intestate.

Claim of rights:

- In the case of a claim to a right in or over any land referred to, the Collector shall pass an order admitting or rejecting the same in whole or in part
- If such claim is admitted in whole or in part, the Collector may either
  (a) exclude such land from the limits of the proposed sanctuary or
  (b) proceed to acquire such land or rights, except where by an agreement between the owner of such land or holder of rights and the Government, the owner or holder of such rights has agreed to surrender his rights to the Government, in or over such land, and on payment of such compensation, as is provided in the Land Acquisition Act, 1894
  (c) allow, in consultation with the Chief Wild Life Warden, the continuation of any right of any person in or over any land within the limits of the sanctuary

Entry into the Protected Area

- No person other than:-
  1. A public servant on duty
  2. A person who has been permitted by the Chief Wild Life Warden or the authorized officer to reside within the limits of the sanctuary/National Park
  3. A person who has any right over immovable property within the limits of the sanctuary/ National Park
  4. A person passing through the sanctuary/National Park along a public highway
  5. The dependents of the person referred to in clause (a), (b) or (c) above,
- Shall enter or reside in the sanctuary/National Park, except under and in accordance with the conditions of a permit granted.

Grant of permit for entry:

- The Chief Wild Life Warden may, on application, grant to any person a permit to enter or reside in a sanctuary/National Park for all or any of the following purposes:
  - investigation or study of wildlife and purposes ancillary or incidental thereto
  - photography
  - scientific research
  - tourism
  - transaction of lawful business with any person residing in the sanctuary
- The Chief Wild Life Warden shall be the authority who shall control, manage and maintain all Protected Areas.
- The National Board for Wild Life may make recommendations on the setting up of and

management of National Parks, Sanctuaries and other protected areas and on matters relating to restriction of activities in those areas.

- The State Board for Wild Life shall advise the State Government on the selection and management of areas to be declared as protected areas.

MEE

- Management Effectiveness Evaluation (MEE) of Protected Areas (PAs) has emerged as a key tool for PA managers and is increasingly being used by governments and international bodies to understand the strengths and weaknesses of the protected area management systems.
- At present, India has a network of 903 Protected Areas in the country covering about 5% of the total geographic area of the country. In order to assess the efficacy of Protected Areas, evaluation of management effectiveness is required.
- Ministry released MEE of 146 National Park and Wildlife Sanctuaries in the Country. The results of present assessment are encouraging with overall mean MEE score of 62.01% which is higher than the global mean of 56%.
- Management Effectiveness Evaluation of Indian Zoos (MEE-ZOO) launched with the framework which proposes guidelines, criteria and indicators for evaluation of zoos of the country.
- The assessment criteria and indicators look beyond the traditional concepts, include issues of animal welfare, husbandry and sustainability of resources and finance.

15.4. CONSERVATION RESERVE AND COMMUNITY RESERVES

- Conservation Reserve and Community Reserves are the outcome of Amendments to the Wild life protection act in 2003.
- It provided for a mechanism to provide recognition and legal backing to the community initiated efforts in wildlife protection.
- It provides for a flexible system wherein the wildlife conservation is achieved without compromising the community needs.

15.4.1. Conservation Reserves

- The Amendment Act of 2003 provided for the creation of a new type of protected area called a Conservation Reserve.
- It is an area owned by the State Government adjacent to National Parks and sanctuaries for protecting the landscape, seascape and habitat of fauna and flora. It is managed through a Conservation Reserve Management Committee
- The State Government may, after having consultations with the local communities, declare any area owned by the Government as conservation reserve.
- Tiruppadaimarathur conservation reserve in Tirunelveli, tamil nadu is the first conservation reserve established in the Country. It is an effort of the village community to protect the birds nesting in their village and acted for declaration of conservation reserve.

15.4.2. Community Reserve

- The Amendment Act of 2003 provided for the creation of a new type of protected area called a Community Reserve.
- The State Government may notify any community land or private land as a Community Reserve, provided that the members of that community or individuals concerned are agreeable to offer such areas for protecting the fauna and flora, as well as their traditions, cultures and practices.
- The declaration of such an area is aimed at improving the socio-economic conditions of the people living in such areas as well as conserving wildlife. The Reserve is managed through a Community Reserve Management Committee
- The State Government may, where the community or an individual has volunteered to conserve wildlife and its habitat, declare the area by notification as community reserve.

- No change in land use pattern shall be made within the Community Reserve, except in accordance with a resolution passed by the Management Committee and approval of the same by the State Government

15.5. COASTAL PROTECTED AREAS

- It aims to protect and conserve the natural marine ecosystems in their pristine condition.
- Marine Protected Area (MPA) as "any area of intertidal or sub tidal terrain, together with its overlaying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" - IUCN.
- Marine productivity in India is concentrated in small areas of coral reefs, lagoons, mangroves, estuaries and seagrass beds around the coast, which provides rich feeding and breeding ground for fish and other marine life.
- MPA protects the vital life support processes of the sea and also ensures sustainable productivity and fish production.
- The MPAs in marine environment in India are primarily classified into following three categories:
- Category-I: This covers National Parks and Sanctuaries and having entire areas in intertidal/sub-tidal or mangroves, coral reefs, creeks, seagrass beds, algal beds, estuaries, lagoons.
- Category-II: This includes Islands, which have major parts in marine ecosystem and some part in terrestrial ecosystem.
- Category-IIIA: This includes sandy beaches beyond intertidal line but occasionally interacting with the seawater.
- Category-IIIB: This includes ever green or semi ever green forests of Islands.
- The Marine Protected Areas (MPAs) in India comprise of a 33 national parks and wildlife sanctuaries designated under the Wildlife (Protection) Act, 1972, encompassing a few of the country's richest coastal habitats.
- Marine National Park and Marine Sanctuary in the Gulf of Kutch form one unit (one MPA). Similarly Bhitarkanika National Park and Bhitarkanika Sanctuary are an integral part of one MPA. Thus, there a total of 31 MPAs in India.
- MPAs cover less than 4.01 % of the total area of all Protected Areas of India.

15.6. SACRED GROVES OF INDIA

- Sacred groves comprise of patches of forests or natural vegetation – from a few trees to forests of several acres – that are usually dedicated to local folk deities.
- These spaces are protected by local communities because of their religious beliefs and traditional rituals that run through several generations.
- The degree of sanctity of the sacred forests varies from one grove to another. In some forests even the dry foliage and fallen fruits are not touched.
- People believe that any kind of disturbance will offend the local deity, causing diseases, natural calamities or failure of crops. For example, the Garo and the Khasi tribes of northeastern India completely prohibit any human interference in the sacred groves. In other groves, deadwood or dried leaves may be picked up, but the live tree or its branches are never cut. For example, the Gonds of central India prohibit the cutting of a tree but allow fallen parts to be used.

15.6.1. Classification of Sacred Groves

- Traditional Sacred Groves – It is the place where the village deity resides, who is represented by an elementary symbol
- Temple Groves – Here a grove is created around a temple and conserved.
- Groves around the burial or cremation grounds.

15.6.2. Distribution of Sacred Groves in India

- In India, sacred groves are found all over the country and abundantly along the western ghats in the states of Kerala and Karnataka.

15.6.3. Ecological Significance

- Conservation of Biodiversity – The sacred groves are important repositories of floral and faunal diversity that have been conserved by local communities in a sustainable manner. They are often the last refuge of endemic species in the geographical region.
- Recharge of aquifers – The groves are often associated with ponds, streams or springs, which help meet the water requirements of the local people. The vegetative cover also helps in the recharging the aquifers.
- Soil conservation - The vegetation cover of the sacred groves improves the soil stability of the area and also prevents soil erosion.

Do you know?

Special measures are being initiated in the keoladeo National Park (NP) to eradicate the African catfish known locally as the Mangur, this invasive species has rapidly come to dominate the park's water bodies and is threatening aquatic and avian fauna here.

15.6.4. Threats to the Sacred Groves

- The threats vary from one region to the other and even from one grove to the other. But the common threats identified are:
- Disappearance of the traditional belief systems, which were fundamental to the concept of sacred groves. These systems and their rituals are now considered mere superstition.
- Sacred groves in many parts of our country have been destroyed due to rapid urbanization and developmental interventions such as roads, railways tracks, dams including commercial forestry. Encroachment has led to the shrinkage of some of the largest groves in the country.
- Many groves are suffering due to 'Sanskritisation' or the transformation of the primitive forms of nature worship into formal temple worship.
- Invasion by exotic weeds such as Eupatorium odoratum, Lantana camara and Prosopis juliflora is a serious threat to some groves.
- Pressures due to increasing livestock and fuelwood collection.

15.7. EXPORT - PROHIBITED GOODS

- The prohibited items are not permitted to be exported. An export licence will not be given in the normal course for goods in the prohibited category.
- The following are the items probited in the flora and fauna category:
  - All wild animals, animal articles including their products and derivatives (excluding those for which ownership certificates have been granted and also those required for transactions for education, scientific research and management under Wild Life (Protection) Act, 1972 including their parts and products).
  - Beef of cows, oxen and calf. Beef in the form of offal of cows, oxen and calf
  - Meat of buffalo (both male and female) fresh and chilled and frozen
  - Peacock Tail Feathers & its Handicrafts and articles
  - Shavings & Manufactured Articles of shavings of Shed Antlers of Chital and Sambhar
  - Sea shells
  - Wood and wood products
  - Fuel wood
  - Wood charcoal
  - Sandalwood in any form,(but excluding finished handicraft products of sandalwood, machine finished sandalwood products, sandalwood oil):
  - Red Sanders wood, Value added products of Red Sanders
  - Mechanical, chemical and semi chemical wood pulp

GLOBAL INITIATIVE

15.8. THE MAN AND BIOSPHERE (MAB)

- The Man and the Biosphere (MAB) Programme is an Intergovernmental Scientific Programme aiming to set a scientific basis for the improvement of the relationships between people and their environment globally.
- Launched in the early 1970s, it proposes an interdisciplinary research agenda and capacity building that target the ecological, social and economic dimensions of biodiversity loss and the reduction of this loss.
- Concerned with problems at the interface of scientific, environmental, societal and development issues, MAB combines natural and social sciences, economics and education to improve human livelihoods and safeguard natural ecosystems, thus promoting innovative approaches to economic development that is socially and culturally appropriate and environmentally sustainable.
- The agenda of the MAB Porgamme is defined by its main governing body, the International Coordinating Council in concertation with the broader MAB Community.
- For implementation of its interdisciplinary work on-ground, MAB relies on the World Network of Biosphere Reserves, and on thematic networks and partnerships for knowledge-sharing, research and monitoring, education and training, and participatory decision-making.
- It predicts the consequences of today's actions on tomorrow's world and thereby increases people's ability to efficiently manage natural resources for the well-being of both human populations and the environment.

15.9. BIOSPHERE RESERVE (BR)

- The International Co-ordinating Council (ICC) of UNESCO, November, 1971, introduced the designation 'Biosphere Reserve' for natural areas.

The concept of Biosphere Reserves was refined by a Task Force of UNESCO's MAB Programme in 1974, and BR network was formally launched in 1976.

15.9.1. Definition

- Biosphere Reserve (BR) is an international designation by UNESCO for representative parts of natural and cultural landscapes extending over large area of terrestrial or coastal/marine ecosystems or a combination thereof.
- BRs are special environments for both people and the nature and are living examples of how human beings and nature can co-exist while respecting each others' needs.
- Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science.
- As places that seek to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature, they are ideal to test and demonstrate innovative approaches to sustainable development from local to international scales.

15.9.2. Characteristics of Biosphere reserve

- The characteristic features of Biosphere Reserves are:

(1) Each Biosphere Reserves are protected areas of land and/or coastal environments wherein people are an integral component of the system.

- Together, they constitute a worldwide network linked by International understanding for exchange of scientific information.

(2) The network of BRs includes significant examples of biomes throughout the world.

(3) Each BR includes one or more of the following categories:-

(i) BRs are representative examples of natural biomes.

(ii) BRs conserve unique communities of biodiversity or areas with unusual natural features of exceptional interest.

(iii) BRs have examples of harmonious landscapes resulting from traditional patterns of land-use.

(iv) BRs have examples of modified or degraded ecosystems capable of being restored to more natural conditions.

(v) BRs generally have a non-manipulative core area, in combination with areas in which baseline measurements, experimental and manipulative research, education and training is carried out. Where these areas are not contiguous, they can be associated in a cluster.

15.9.3. Functions of Biosphere Reserves

Conservation

- To ensure the conservation of landscapes, ecosystems, species and genetic variations.
- To encourage the traditional resource use systems;
- To understand the patterns and processes of functioning of ecosystems;
- To monitor the natural and human-caused changes on spatial and temporal scales;

Development

- To promote, at the local level, economic development which is culturally, socially and ecologically sustainable.
- To develop the strategies leading to improvement and management of natural resources;

Logistics support

- To provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development
- Sharing of knowledge generated by research through site specific training and education; and
- Development of community spirit in the management of natural resources.

Beneficiaries

- Direct Beneficiaries - local people and the ecological resources of the Biosphere Reserves
- indirect beneficiaries - world community.

Biosphere Reserves: an Indian approach

- It is this ecological diversity that makes India as one of the mega-diversity regions on the globe. Efforts are on to designate at least one Biosphere Reserve in each of the Biogeographic Provinces.

15.9.4. National Biosphere Reserve Programme.

- The national Biosphere Reserve Programme was initiated in 1986.
- To ensure participation of local inhabitants for effective management and devise means of improving livelihood of the local inhabitants through sustainable use.

Objectives

- It may be noted that BRs are not a substitute or alternative, but a re-enforcement to the existing protected areas. The objectives of the Biosphere Reserve programme, as envisaged by the Core Group of Experts, are as follows:
- To conserve the diversity and integrity of plants and animals within natural ecosystems;
- To safeguard genetic diversity of species on which their continuing evolution depends;
- To provide areas for multi-faceted research and monitoring;
- To provide facilities for education and training; and
- To ensure sustainable use of natural resources through most appropriate technology for improvement of economic well-being of the local people.
- These objectives should be oriented in such a way that the BRs are the Units wherein the Biological, socio-economic and cultural dimension of conservation are integrated together into a realistic conservation strategy.

15.9.5. Criteria for selection of BRs

- The criteria for selection of sites for BRs as laid down by the Core Group of Experts in 1979 are listed below:

Primary criteria

- A site that must contain an effectively protected and minimally disturbed core area of value of nature conservation and should include additional land and water suitable for research and demonstration of sustainable methods of research and management.
- The core area should be typical of a biogeographical unit and large enough to sustain viable populations representing all tropic levels in the ecosystem.

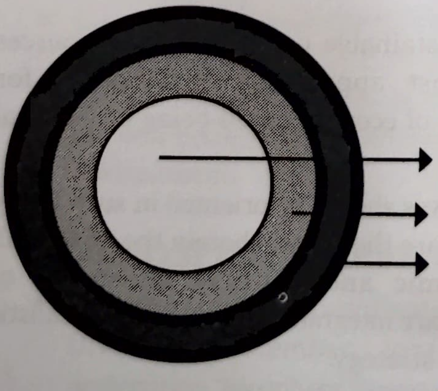
Secondary criteria

- Areas having rare and endangered species
- Areas having diversity of soil and micro-climatic conditions and indigenous varieties of biota.
- Areas potential for preservation of traditional tribal or rural modes of living for harmonious use of environment.

15.9.6. Structure and Design of Biosphere Reserves

- In order to undertake complementary activities of biodiversity conservation and development of sustainable management aspects, Biosphere Reserves are demarcated into three inter-related zones.

1. The Core Zone:



- The core zone should be kept absolutely undisturbed. It must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism. A core zone secures legal protection and management and research activities that do not affect natural processes and wildlife are allowed. Strict nature reserves and wilderness portions of the area are designated as core areas of BR. The core zone is to be kept free from all human pressures external to the system.

2. The Buffer Zone:

- Buffer Zone adjoins or surrounds core zone. Its uses and activities are managed in ways that protect the core zone. These uses and activities include restoration, demonstration sites for enhancing value addition to the resources, limited recreation, tourism, fishing and grazing, which are permitted to reduce its effect on core zone. Research and educational activities are to be encouraged. Human activities, if natural within BR, are likely to be permitted to continue if these do not adversely affect the ecological diversity.

3. The Transition Zone:

- The Transition Zone is the outermost part of a Biosphere Reserve. This is usually not delimited one and is a zone of cooperation where conservation, knowledge and management skills are applied and uses are managed in harmony with the purpose of the Biosphere Reserve. This includes settlements, crop lands, managed forests and area for intensive recreation, and other economic uses characteristic of the region.
- (In Buffer Zone and the Transition Zones, manipulative macro-management practices are used. Experimental research areas are used for understanding the patterns and processes in the

ecosystem. Modified or degraded landscapes are included as rehabilitation areas to restore the ecology in a way that it returns to sustainable productivity).

15.9.7. How Biosphere Reserves are different from protected areas?

- BR is not intended to replace existing protected areas but it widens the scope of conventional approach of protection and further strengthens the Protected Area Network.
- Existing legally protected areas (National Parks, Wildlife Sanctuary, Tiger Reserve and reserve/protected forests) may become part of the BR without any change in their legal status.
- On the other hand, inclusion of such areas in a BR will enhance their national value.

However, the Biosphere Reserves differ from protected areas due to their emphasis on:

(i) Conservation of overall biodiversity and landscape, rather than some specific flagship species, to allow natural and evolutionary processes to continue without any hindrance.

(ii) Different components of BRs like landscapes, habitats, and species and land races.

(iii) Developmental activities, and resolution/mitigation of conflicts between development and conservation,

(iv) Increase in broad-basing of stakeholders, especially local people's participation and their Training, compared to the features of scheme on Wildlife Sanctuaries and National Parks.

(v) Sustainable environment friendly development, and sustained coordination amongst different development organizations and agencies.

(vi) Research and Monitoring to understand the structure and functioning of ecological system and their mode of reaction when exposed to human intervention.

- The Indian National Man and Biosphere Committee constituted by the Central Govt. identifies new sites, advises on policies and programmes, lays down guidelines, reviews progress and guidelines in the light of evaluation studies and feed back.
- The Management of Biosphere Reserves is the responsibility of the concerned State/UT with necessary financial assistance, guidelines for management and Technical expertise provided by the Central Government.
- BR are internationally recognized within the framework of UNESCO's Man and Biosphere (MAB) programme, after receiving consent of the participating country.

15.10. WORLD NETWORK OF BIOSPHERE RESERVES (WNBR)

15.10.1. The World Network

- In order to facilitate cooperation, BRs are admitted into International network by International Coordinating Council (ICC) of the Man and Biosphere (MAB) Programme of UNESCO on the request of the participating country subject to their fulfillment of prescribed criteria.
- The BRs remain under the sole sovereignty of the concerned country/state where it is situated, and participation in World Network is voluntary.
- Delisting from international Network is done as an exception on ground of violation of obligation for conservation and sustainable development of Biosphere Reserves after consulting the concerned Government.
- The MAB programme's primary achievement is the creation in 1977 of the World Network of Biosphere Reserves.
- Composed of 610 biosphere reserves in 117 countries, including 12 transboundary sites, the WNBR of the MAB Programme promotes North-South and South-South collaboration and

represents a unique tool for international co-operation through sharing knowledge, exchanging experiences, building capacity and promoting best practices.

15.11. BIODIVERSITY HOT SPOTS

- Biodiversity hot spot concept was put forth by Norman Myers in 1988
- To qualify as a hot spot, a region must meet two strict criteria:
  a. Species endemism - it must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics, and
  b. Degree of threat - it has to have lost at least 70% of its original habitat.
- Each biodiversity hot spot represents a remarkable universe of extraordinary floral and faunal endemicity struggling to survive in rapidly shrinking ecosystems.
- Over 50 percent of the world's plant species and 42 percent of all terrestrial vertebrate species are endemic to the 35 biodiversity hot spots.

15.11.1. The hottest hot spots

- Some hot spots are much richer than others in terms of their numbers of endemics.
- Five key factors have been taken into consideration and those biodiversity hot spot tops the list with respect to these five factors are considered as hottest hot spots.

Factors

1. Endemic plants
2. Endemic vertebrates
3. Endemic plants/area ratio (species per 100km^2)
4. Endemic vertebrates/area ratio (species per 100km^2)
5. Remaining primary vegetation as % of original extent

The eight hottest hot spots in terms of five factors

1. Madagascar
2. Philippines
3. Sundaland
4. Brazil's Atlantic Forest
5. Caribbean
6. Indo-Burma
7. Western Ghats/Sri Lanka
8. Eastern Arc and Coastal Forests of Tanzania/Kenya

These eight `hottest hot spots', appear at least three times in the top ten listings for each factor.

15.11.2. Indian Biodiversity Hot Spots.

- There are 4 biodiversity hot spots present in India. They are:

1. The Himalayas
2. Indo- Burma and
3. The western Ghats & Sri Lanka
4. Sunderland

1. The Eastern Himalayas Hot Spot

About the region:

- The Eastern Himalayas is the region encompassing Bhutan, northeastern India, and southern, central, and eastern Nepal. The region is geologically young and shows high altitudinal variation.
- The abrupt rise of the Himalayan Mountains from less than 500 meters to more than 8,000 meters results in a diversity of ecosystems that range from alluvial grasslands and subtropical broad leaf forests along the foothills to temperate broad leaf forests in the mid hills, mixed conifer and conifer forests in the higher hills, and alpine meadows above the tree line.

2. Indo-Burma Region:

- The Indo-Burma region encompasses several countries.
- It is spread out from Eastern Bangladesh to Malaysia and includes North-Eastern India south of Brahmaputra river, Myanmar, the southern part of China's Yunnan province, Lao People's Democratic Republic, Cambodia, Vietnam and Thailand.

3. Western Ghats and Sri Lanka:

- Western Ghats, also known as the "Sahyadri Hills" encompasses the mountain forests in the southwestern parts of India and highlands of southwestern Sri Lanka.
- The entire extent of hotspot was originally about 1,82,500 square kms, but due to tremendous population pressure, now only 12,445 square Km or 6.8% is in pristine condition.
- The wide variation of rainfall patterns in the Western Ghats, coupled with the region's complex geography, produces a great variety of vegetation types.
- These include scrub forests in the low-lying rainshadow areas and the plains, deciduous and tropical rainforests up to about 1,500 meters, and a unique mosaic of montane forests and rolling grasslands above 1,500 meters.
- In Sri Lanka diversity includes dry evergreen forests to dipterocarpus dominated rainforests to tropical montane cloud forest.

15.12. BIODIVERSITY COLDSPOTS

- Areas that have relatively low biological diversity but are also experiencing a high rate of habitat loss. Although a biodiversity coldspot is low in species richness, it can also be important to conserve, as it may be the only location where a rare species is found. Extreme physical environments (low or high temperatures or pressures, or unusual chemical composition) inhabited by just one or two specially adapted species are coldspots that warrant conservation because they represent unique environments that are biologically and physically interesting.

5.13. 'MARINE MEGA FAUNA STRANDING GUIDELINES'

aim to improve coordination between various independent governments and civil societies responding to marine stranding, research and management, data sharing and thus promote inter-sectoral coordination in the conservation of marine animals.

- to prepare a database on cetacean sighting and stranding across the country, and help set up a national stranding centre and in the state with district/local coordinator with high stranding and bycatch cases.
- The role of a marine wildlife stranding network is to inform, rescue/rehab, collect biological information and if possible, ascertain cause of death of animals.
- A basic marine stranding network will consist of first responders, forest guard, divisional forest officer, government official veterinary and marine police.
- A first responder keeps a live individual comfortable and a dead individual from getting washed back into the sea and helps the scientists, veterinarians and the departments in data collection or rescue release operations.
- In case of live stranding, where the animal can be released into the sea, they will be tagged.
- for long-term conservation of marine species and their habitats.

15.14. WORLD HERITAGE SITES

- World Heritage Sites means "Sites any of various areas or objects inscribed on the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) World Heritage List".
- The sites are designated as having outstanding universal value under the Convention concerning the Protection of the World Cultural and Natural Heritage.

- This Convention, which was adopted by the UNESCO in 1972 (and enforced in 1975) provides a framework for international cooperation in preserving and protecting cultural treasures and natural areas throughout the world.
- The convention defines the kind of sites which can be considered for inscription of the World heritage list (ancient monuments, museums, biodiversity and geological heritage etc.,), and sets out the duties of the State Parties in identifying potential sites and their role in protecting them.
- Although many World Heritage sites fall into either the 'cultural' or 'natural'categories, a particularly important aspect of the convention is its ability to recognise ladscapes that combine these values, and where the biological and physical aspects of landscape have evolved alongside human activity.
- The first list of World Heritage state was published in 1978.
- The World Heritage Convention reiterates that the protection on sites should be dovetailed with regional planning programmes. This is not happening always. (Agra city developments do not go well the conversation of Taj Mahal is a point).
- "Natural heritage sites are restricted to those natural areas that
    1. furnish outstanding examples of the Earth's record of life or its geologic processes.
    2. provide excellent examples of ongoing ecological and biological evolutionary processes.
    3. contain natural phenomena that are rare, unique, superlative, or of outstanding beauty or
    4. furnish habitats or rare endangered animals or plants or are sites of exceptional biodiversity".
- Until the end of 2004, there were six criteria for cultural heritage and four criteria for natural heritage. In 2005 this was modified so that there is only one set of ten criteria. Nominated sites must be of "outstanding universal value" and meet at least one of the ten criteria. The criteria are given below.

15.14.1 Criteria

I. "to represent a masterpiece of human creative genius";

II. "to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design?".

III. "to bear a unique or atleast exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared?;

IV. "to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates a significat stage(s) in human history";

V. "to be an outstanding example of a traditional human settlemnet, land-use, or sea-use, which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change";

VI. "to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria).

VII. "to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance";

VIII."to be outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processess in the development of landforms, or significant geomorphic or psysiographic features";

IX. "to be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystem and communities of plants and animals";

X. "to contain the most important and significant natural habitats for insists conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

- The UNESCO funds numerous efforts to preserve and restore World Heritage Sites in developing nations. It maintains also a List of World Heritage Sites in developing nations. It maintains also a List of World Heritage in danger facing threat of pollution and other natural hazards. Sites subject to unusual levels of pollution, natural hazards, or other problems may be placed for restoration. Such designated sites facilitate promotion of tourism.

World Heritage Forests

This report was jointly released by UNESCO, the World Resources Institute (WRI), and the International Union for Conservation of Nature (IUCN).

Report provides the first global scientific assessment of greenhouse gas emissions and sequestration by forests in UNESCO World Heritage sites (WHS). Most of the World Heritage Forest carbon is stored in tropical sites.Report estimates that forests across WHS removed approximately 190 million tonnes of CO_2 per year between 2001 and 2020 from the atmosphere.

International Year of Biodiversity

- The United Nations declared 2010 to be the International Year of Biodiversity. It is a celebration of life on earth and of the value of biodiversity for our lives.

International Day for Biological Diversity - 22 May

- The United Nations proclaimed May 22 as The International Day for Biological Diversity (IDB) to increase understanding and awareness of biodiversity issues.
- Initially 29 December (the date of entry into force of the Convention of Biological Diversity), was designated The International Day for Biological Diversity by the UN General Assembly in late 1993.
- In December 2000, the UN General Assembly adopted 22 May as IDB, to commemorate the adoption of the text of the Convention on 22 May 1992 by the Nairobi Final Act of the Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity.

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CHAPTER - 16

CONSERVATION EFFORTS

16.1. PROJECT TIGER

A potential example of conservation of a highly endangered species is the Indian Tiger (Panthera tigris). The fall and rise in the number of Tiger population in India is an index of the extent and nature of conservation efforts.

It is estimated that India had about 40 000 tigers in 1900, and the number declined to a mere about 1800 in 1972.

Hence, Project Tiger centrally sponsored scheme was launched in 1973 with the following objectives:

- To ensure maintenance of available population of Tigers in India for scientific, economic, aesthetic, cultural and ecological value
- To preserve, for all times, the areas of such biological importance as a national heritage for the benefit, education and enjoyment of the people

Aim

(i) Conservation of the endangered species and

(ii) Harmonizing the rights of tribal people living in and around tiger reserves

Do you know?

The scientific name for the tiger is Panthera tigris There are eight subspecies of tiger: among the eight, at present five subspecies are present in the wild. They are - Bengal, South China, Indochinese, Sumatran, and Siberian. Three subspecies of tiger—Caspian, Bali, and Javan—are extinct.

16.1.1. Tiger Reserve

- Tiger reserves are areas that are notified for the protection of the tiger and its prey, and are governed by Project Tiger which was launched in the country in 1973.
- Initially 9 tiger reserves were covered under the project, and has currently increased to 54, falling in 18 States (tiger reserve States).
- The State Government shall, on recommendation of the National Tiger Conservation Authority, notify an area as a tiger reserve.

A Tiger reserve includes:

a) Core zone

- Critical tiger habitat areas established, on the basis of scientific and objective criteria.
- These areas are required to be kept as inviolate for the purposes of tiger conservation, without affecting the rights of the Scheduled Tribes or such other forest dwellers.
- These areas are notified by the State Government in consultation with an Expert Committee (constituted for that purpose)

b) Buffer zone

- Peripheral area to critical tiger habitat or core area, where a lesser degree of habitat protection is required to ensure the integrity of the critical tiger habitat with adequate dispersal for tiger species.

- It aims at promoting co-existence between wildlife and human activity with due recognition of the livelihood, developmental, social and cultural rights of the local people.
- The limits of such areas are determined on the basis of scientific and objective criteria in consultation with the concerned Gram Sabha and an Expert Committee constituted for the purpose.
- No alteration in the boundaries of a tiger reserve shall be made except on a recommendation of the National Tiger Conservation Authority and the approval of the National Board for Wild Life.
- No State Government shall de-notify a tiger reserve, except in public interest with the approval of the National Tiger Conservation Authority and the approval of the National Board for Wild Life.

16.1.2 National Tiger Conservation Authority (NTCA):

- The Amendment Act of 2006 provides for the constitution of a statutory authority known as the National Tiger Conservation Authority to aid in the implementation of measures for the conservation of the tiger.

Do you know?

No two tigers have exactly the same pattern of stripes. Tigers live alone, except for mothers and their young. A male and female tiger come together to mate, and then go their separate ways.

Powers and functions:

1. To approve the Tiger Conservation Plan prepared by the State Government
2. To evaluate and assess various aspects of sustainable ecology and disallow any ecologically unsustainable land use such as mining, industry and other projects within tiger reserves
3. To lay down normative standards for tourism activities and guidelines for project tiger from time to time for tiger conservation in the buffer and core area of tiger reserves and ensure their due compliance
4. To provide information on protection measures including future conservation plan, estimation of population of tiger and its natural prey species, status of habitats, disease surveillance, mortality survey, patrolling, reports on untoward happenings and such other management aspects as it may deem fit including future plan of conservation
5. To ensure that tiger reserves and areas linking on protected area or tiger reserve with another protected area or tiger reserve are not diverted for ecologically unsustainable uses, except in public interest and with the approval of the National Board for Wild Life.
6. To facilitates and support tiger reserve management in the State for biodiversity conservation initiatives through eco-development and peoples participation as per approved management plans, and to support similar initiatives in adjoining areas consistent with the Central and State laws
7. To ensure critical support including scientific, information technology and legal support for better implementation of the tiger conservation plan
8. To facilitate ongoing capacity building program for skill development of officers and staff of tiger reserves

16.1.3. Estimation of Tiger Populations

- The process of estimating the number of tigers in a given area is called 'Tiger census.'
- This exercise provides us with an estimate of tiger number, density and change in tiger indices - a measure of tiger occupancy in a given area.
- It is conducted at regular intervals to know the current tiger populations and population trends.
- Besides estimating the number of tigers the method also helps to gather information on the density of the tiger populations and associated prey.
- The most commonly used technique in the past was 'Pugmark Census Technique'. In this method the imprints of the pugmark of the tiger were recorded and used as a basis for identification of

individuals. Now it is largely used as one of the indices of tiger occurrence and relative abundance.

- Recent methods used to estimate the numbers of tigers are camera trapping and DNA finger-printing.
- In camera trapping, the photograph of the tiger is taken and individuals are differentiated on the basis of the stripes on the body.
- In the latest technique of DNA fingerprinting, tigers can be identified from their scats.

2010 Assessment Methodology

- The All India Tiger Estimation exercise is one of the most crucial components of our national tiger conservation efforts.
- Since 2006, this monitoring exercise is being undertaken every four years.
- This report presents the results of the 2010 National Tiger Assessment, undertaken through a best-in-class scientific process.
- This presents an estimate of India's current tiger population and a broader assessment of our tiger landscapes.
- The three phases of the tiger estimation procedure are as follows:
    - Phase 1: Field data collected at the beat-level (i.e. the primary patrolling unit) by trained personnel using a standardised protocol.
    - Phase 2: Analysis of habitat status of tiger forests using satellite data.
    - Phase 3: Camera trapping was the primary method used, where individual tigers were identified from photographs based on their unique stripe patterns. This information was analysed using a well established scientific framework. Camera trapping was carried out by teams of wildlife biologists and local forest personnel.
- Based on the tiger numbers recorded in sampled sites, an estimate for other contiguous tiger-occupied landscapes, was made. For this, additional information such as tiger signs, prey availability, habitat conditions and human disturbance was used. Thus, the final estimates provide a comprehensive and statistically robust result for the whole country

"Phase IV"

- India has announced a major expansion of its tiger monitoring programme, through 'Phase IV' of the national tiger estimation programme.
- This initiated intensive, annual monitoring of tigers at the tiger reserve level, across protected areas in the country, from November 2011.
- The methodology is developed by the Wildlife Institute of India (WII) and the National Tiger Conservation Authority (NTCA), in consultation with experts, and will use statistically sound procedures to estimate numbers of both tigers and their prey.
- The tiger monitoring protocol use camera traps, at a density of 25 double-sided cameras per 100 square kilometres, and a minimum trapping effort of 1000 trap nights per 100 square kilometres. **(Note: Tiger reserve - see appendix)**
- This will provide a yearly indication of the status of critical tiger populations around the country, and will be critical to long-term management and conservation of tiger populations.
- Prey population monitoring will be conducted simultaneously, using Distance sampling protocols. Distance sampling will be conducted along line transects already established in phase I, and will use a minimum of 30 spatial replicates for 2 km each, and a total effort of 300 km.

Do you know?

Pugmark Census Technique'. In this method the imprints of the pugmark (foot print) of the tiger were recorded and used as a basis for identification of individuals. Now it is largely used as one of the indices of tiger occurrence and relative abundance.

Innovations in 2010 National Tiger Assessment

- The 2010 National Tiger Assessment has several innovations over previous assessments. These include:

- Partnerships with civil society organizations
- Local communities involved in data collection and analysis.
- Genetic analysis to estimate tiger populations from faecal samples.
- Along with tigers, co-predators, prey, and habitat quality assessed.
- Pioneering attempt to estimate tiger populations in Sunderbans Tiger Reserve (West Bengal) using satellite telemetry and sign surveys.
- First estimation of tiger population in Sahyadri Tiger Reserve (Maharashtra).

Tiger Population Estimates

- The same scientifically robust methods were consistently used in 2006 and 2010. This enabled comparison of results from both estimation exercises and in understanding the trend in tiger numbers.
- The estimated tiger population in 2006 was 1411 and due to conservation efforts it has steadily increased and the tiger population was 1706 in the 2010 tiger estimate and 2226 tigers in 2014 tiger census.

All India Tiger Estimation – 2022

- Record for being world largest camera trap wildlife survey again after 2018.
- India has nearly 75% of World Tiger Population.
- According to the fifth cycle of All India Tiger Estimation – 2018, the count of tigers in India has risen to 3080. Madhya Pradesh has the highest number of tigers at 785, closely followed by Karnataka at 563 with Uttarakhand at number 3 with 560 tigers.
- Central India and the Shivalik Hills and Gangetic Plains witnessed a notable increases in tiger population, particularly in the states of Madhya Pradesh, Uttarakhand, and Maharashtra.
- However, certain regions, such as the Western Ghats, experienced localized declines, necessitating targeted monitoring and conservation efforts.
- Some states, including Mizoram, Nagaland, Jharkhand, Goa, Chhattisgarh, and Arunachal Pradesh, have reported disquieting trends with small tiger populations.
- India achieved its commitment to the St.Petersburg Declaration, of doubling Tiger population, much in advance to the 2022 deadline.

Do you know?

The Maharashtra government has proposed setting up a tiger research institute in the state. The proposal was submitted to the central government during the 'Third Asia Ministerial Conference on Tiger Conservation' that was held recently in New Delhi. The location proposed is Nagpur or Chandrapur, as there are 13 tiger reserves with 350 tigers located within a 300-km radius of either of these two places.

16.1.4 International Cooperation

- India has a Memorandum of Understanding with Nepal on controlling trans-boundary illegal trade in wildlife and conservation, apart from a protocol on tiger conservation with China.
- The process is on for bilateral protocol with Bangladesh, Bhutan & Myanmar.
- A Global Tiger Forum of Tiger Range Countries has been created for addressing international issues related to tiger conservation.

Asian Ministerial Conference on Tiger Conservation.

- The New Delhi Resolution on Tiger Conservation was adopted by the 3rd Asian Ministerial Conference on Tiger Conservation.
- The salient features of the Resolution include: recovery of tiger in low density protected areas by three Rs – Restoration, Reintroduction and Rehabilitation, acceleration of the implementation of Global Tiger Recovery Programme, which includes habitat improvement and anti-poaching surveillance through modern technology, align

development and tiger conservation by ensuring intensive participation of locals and other stakeholders, promotion of tiger habitats to provide ecosystem service, economic growth and addressing climate change and strengthening cooperation to combat wildlife crime.

- This is the third conclave, with the earlier ones being held at Hua Hin, Thailand (2010) and Thimpu, Bhutan (2012), besides the Tiger Summit at St Petersburg in 2010. Tiger Range Countries include Bangladesh, Bhutan, Cambodia, China, Indonesia, India, Lao PDR, Malaysia, Myanmar, Nepal, Russian Federation, Thailand, Vietnam.

Do you know?

Four years after the Maharashtra government launched a project to monitor and protect wild buffaloes at the Kolamarka Conservation Reserve at Sironcha in Gadchiroli, the numbers have shown a gradual rise. Now, the state government is considering a proposal tiger reserve for a higher degree of protection.

16.1.5 CA|TS

- CA|TS is a set of criteria which allows tiger sites to check if their management will lead to successful tiger conservation.
- Officially launched in 2013, it sets minimum standards for effective management of target species and encourages assessment of these standards in relevant conservation areas.
- The 14 Tiger Reserves in India which received the accreditation of the Global Conservation Assured|Tiger Standards (CA|TS).
- Conservation Assured | Tiger Standards (CA|TS) has been agreed upon as accreditation tool by the global coalition of Tiger Range Countries (TRCs) and has been developed by tiger and protected area experts in 18 tiger bearing states of the country.

16.2 PROJECT LION

- Increase in the number of Asiatic lions in Gujarat's Gir forest from 523 in 2015 to to 674 in 2020.
- Lion relocation has been talked since 1995, when the Kuno Wildife Sanctuary was identified as an alternate site. The motive behind finding a relocation site for the species is because the population in Gir has low genetic diversity, making it vulnerable to threats of extension from epidemics. The proposal sought to create free-ranging lion population within Gujarat and in other states to counter this problem. The Supreme Court also issued a order in 2013 directing the state to relocate lions to the Kuno-Palpur Wildlife Sanctuary.
- the CSIR-Centre for Cellular and Molecular Biology, Hyderabad sequenced the entire genome of the Asiatic lion and it has shown them to be lacking genetic diversity in comparison to other lion populations and historical samples of Asiatic lions.
- Six new sites apart from the Kuno-Palpur Wildlife Sanctuary have been identified under Project Lion for possible lion relocation in the future include:
  1. Madhav National Park, Madhya Pradesh
  2. Sitamata Wildlife Sanctuary, Rajasthan
  3. Mukundra Hills Tiger Reserve, Rajasthan
  4. Gandhi Sagar Wildlife Sanctuary, Madhya Pradesh
  5. Kumbhalgarh Wildlife Sanctuary, Rajasthan
  6. Jessore-Balaram Ambaji WLS and adjoining landscape, Gujarat
- Central Government launched "Asiatic Lion Conservation Project" for three financial years 2018-21 with an aim to protect and conserve the world's last ranging free population of Asiatic Lion and its associated ecosystem.
- The project will be funded from the Centrally Sponsored Scheme- Development of Wildlife Habitat (CSS-DWH) with the contributing ratio being 60:40 of Central and State share.

- The Asiatic Lion, endemic to Gir landscape of Gujarat, is one of the 21 critically endangered species identified by the Ministry for taking up recovery programmes. Asiatic Lion, being listed in Schedule-I of Wildlife (Protection) Act, 1972, to be accorded the highest degree of protection.
- This project has "Species Conservation over a large landscape" approach. Besides this approach, the Greater Gir Region (GGR) is being divided into various zones and management approach of "Zone Plans and Theme Plans" for the conservation of the Asiatic Lion.

Do you know?

The Rajasthan government has decided not to set up any windmills for wind power projects in the areas inhabited by the Great Indian Bustard (GIB). A majority of wind power projects in Rajasthan have come up in and around the desert town of Jaisalmer which is also one of the main areas for these birds.

16.3. PROJECT ELEPHANT

- Project Elephant was launched in February, 1992 as centrally sponsored scheme to assist states having free ranging populations of wild elephants and to ensure long term survival of identified viable populations of elephants in their natural habitats.
- The Project is being mainly implemented in 13 States / UTs , viz. Andhra Pradesh, Arunachal Pradesh, Assam, Jharkhand, Karnataka, Kerala, Meghalaya, Nagaland, Orissa, Tamil Nadu, Uttaranchal, Uttar Pradesh and West Bengal. Small support is also being given to Maharashtra and Chhattisgarh.
- States are being given financial as well as technical assistance in achieving the objectives of the Project. Help is also provided to other states with small populations of elephants for the purpose of census, training of field staff and mitigation of human-elephant conflict.

Objectives:

- To protect elephants, their habitat & corridors
- To address issues of man-animal conflict
- Welfare of domesticated elephants

Aim

- Ecologically restoring the natural habitats and migratory routes of the elephants
- Mitigation of the increasing conflicts between man and elephants in important habitats and moderating the pressures of human and domestic stock activities in important elephant habitats.
- Developing scientific and planned management measures for conservation of elephants.
- Protecting the elephants from poachers and other unnatural causes of death and preventing illegal ivory trade is also one of the major concerns of the Elephant Project in India
- Researching on issues related to elephants and creating public awareness and education programs for it.
- Eco-development and Veterinary care for the elephants.
- It also aims at maintaining health care and breeding of tamed elephants.
- **(Elephant reserve of India see appendix)**
- The Project Tiger division has been merged with Project Elephant and a new division with the name 'Project Tiger and Elephant Division' has been created under the Ministry of Environment, Forest and Climate Change (MoEF&CC).

16.3.1. Elephant Corridor

- An elephant corridor is defined as a stretch/ narrow strips of forested (or otherwise) land that connects larger habitats with elephant populations and forms a conduit for animal movement between the habitats. This movement helps enhance species survival and birth rate.
- There are 150 identified elephant corridors in India.

- Out of total 150 corridors, 32 were in south India, 12 in north-western India, 32 in central India, 26 in northern West Bengal and 48 in north-eastern India.
- Of the total, 77.3 per cent is regularly used by elephants. About one-third is of ecologically high priority and remaining two third of medium priority.
- Fragmentation of elephant habitat was severe in northern West Bengal followed by north-western India, north-eastern India and central India respectively. The least fragmentation was noted in south India.
- In south India, 65 per cent of the corridors are in protected area or in reserved forests.
- 90 per cent in central India are jointly under forest, agriculture and settlements, Only 10 per cent are completely under forest area.
- Nationally, only 24 per cent of the corridors are under complete forest cover.

16.3.2. Threats to Elephant Corridors

- The primary threat is the Habitat loss leading to fragmentation and destruction caused by developmental activities like construction of buildings,roeds, railways, holiday resorts and the fixing solar energized electric fencing, etc.
- Coal mining and iron ore mining is the two "single biggest threats" to elephant corridors in central India.
- Orissa, Jharkhand and Chhattisgarh, are mineral-rich states, but also have the highest number of elephant corridors in the country, which makes them known for elephant-man conflicts.
- There is also a serious poaching problem, as elephant ivory from the tusks is extremely valuable.
- Elephants need extensive grazing grounds and most reserves cannot accommodate them. If protected areas are not large enough, elephants may search for food elsewhere. This often results in conflicts with humans, due to elephants raiding or destroying crops.

Do you know?

Rajiv Gandhi Wildlife Conservation Award is Awarded annually for significant contribution in the field of wildlife conservation which has made or has the potential to make, a major impact on the protection and conservation of wildlife in the country

16.3.3. Mitigation

- Fusion of the corridors with nearby protected areas wherever feasible; in other cases, declaration as Ecologically Sensitive Areas or conservation reserves to grant protection.
- During the process of securing a corridor, monitoring for animal movement have to be carried out; depending on the need, habitat restoration work shall also be done.
- Securing the corridors involves sensitizing local communities to the option of voluntarily relocation outside the conflict zones to safer areas. It would also have great conservation value, preventing further fragmentation of the continuous forest habitat by encroachment from urban areas, as well as providing continued refuge for tiger, elephant, sambar, marsh crocodile, gharial and many species of bird.

16.3.4. Monitoring of Illegal Killing of Elephants (MIKE) Programme

- Mandated by COP resolution of CITES, MIKE program started in South Asia in the year 2003 with following purpose –
- To provide information needed for elephant range States to make appropriate management and enforcement decisions, and to build institutional capacity within the range States for the long-term management of their elephant populations

Main objectives

1. to measure levels and trends in the illegal hunting of elephants;
2. to determine changes in these trends over time; and

3. to determine the factors causing or associated with such changes, and to try and assess in particular to what extent observed trends are a result of any decisions taken by the Conference of the Parties to CITES

- Under the programme data are being collected from all sites on monthly basis in specified MIKE patrol form and submited to Sub Regional Support Office for South Asia Programme located in Delhi who are assisting Ministry in the implementation of the progremme.

Do you know?

Hi-tech patrolling is set to be introduced in the Similipal tiger Reserve (STR) ahead of Maha Vishuva Sankranti, a religious function when tribals indulge in a ritual of mass killing of wild animals in the forests here.

16.3.5. Haathi Mere Saathi

- Haathi Mere Saathi is a campaign launched by the Ministry of environment and forest (MoEF) in partnership with the wildlife trust of India (WTI).
- To improve conservation and welfare prospects of the elephant - India's National Heritage Animal.
- The campaign was launched at the "Elephant- 8" Ministerial meeting held in Delhi on 24th May 2011.
- The E-8 countries comprise of India, Botswana, the Republic of Congo, Indonesia, Kenya, Srilanka, Tanzania, and Thailand.
- This public initiative was aimed at increasing awareness among people and developing friendship, companionship between people and elephants.

The campaign mascot 'Gaju'.

- The campaign focuses on various target audience groups including locals near elephant habitats, youth, policy makers, among others.
- It envisions setting up of Gajah (the elephant) centres in elephant landscapes across the country to spread awareness on their plight and invoke people's participation in addressing the threats to them.
- It also plants to build capacity of protection and law enforcement agencies at the ground level, and advocate for policies favouring the pachyderms (the elephant).
- Recommended by the elephant task force (ETF) constituted by the ministry last year, the campaign to "Take Gajah (the elephant) to the prajah (the people)" aims to spread awareness and encourage people's participation in elephant conservation and welfare.

Tiger, faces threat of extinction, whereas the elephant faces threat of attrition. The elephant numbers have not increased or decreased drastically but there is a increasing pressure on the elephant habitats and it is a serious concern which has to be addressed by involving people in elephant conservation and welfare through this campaign.

- The Asian elephant is threatened by habitat degradation, conflicts and poaching for ivory. These threats are more intense in India which harbours more than 50% of worlds Asian elephant population.
- India has about 25000 elephants in the wild. Despite this seemingly large number, the elephant particularly the tuskers (male), in India is as threatened as the tiger. There are just about 1200 tuskers left in the country.

16.3.6. Elephant - 8 Ministerial Meeting

- The E-8 ministerial meeting represented regions with all 3 species of elephants, viz.,
  1. Elephas maximus (Asian elephant)
  2. Loxodonta africana (African Bush Elephant)
  3. Loxodonta cyclotis (African Forest Elephant)
- The participants included policy makers, conservationist, scientists, historians, art and culture experts among the participating countries.
- Discussions covered a wide range of issues categorised under three basic themes.
  1. Science and conservation

2. Management and conservation
3. Cultural and Ethical perspectives of conservation

- The E-8 countries besides resolving to take necessary steps in the direction of elephant conservation also decided to actively pursue a common Agenda to ensure a long term welfare and survival of all species of elephants in all range countries.
- To realise this global goal, the meeting has called upon all range countries to join hands under
- the umbrella of elephant-50:50 forum. It is the shared vision of 50 states to promote conservation, management and welfare of elephants in the next 50 years.

16.3.7. E-50:50 forum

- The E-8 countries decided to hold the 1st International Congress of E-50:50 forum in early 2013 at New Delhi, India for adopting a common global vision on conservation, management and welfare of elephants across all range countries.

Do you know?

Amrita Devi Bishnoi Wildlife Protection Award is given for significant contribution in the field of wildlife protection, which is recognised as having shown exemplary courage or having done exemplary work for the protection of wildlife.

16.4. PROJECT VULTURE

India has nine species of vultures in the wild. They are the

1. Oriental White-backed Vulture (Gyps bengalensis),
2. Slender billed Vulture (Gyps tenuirostris),
3. Long billed Vulture (Gyps indicus),
4. Egyptian Vulture (Neophron percnopterus),
5. Red Headed Vulture (Sarcogyps calvus),
6. Indian Griffon Vulture (Gyps fulvus),
7. Himalayan Griffon (Gyps himalayensis),
8. Cinereous Vulture (Aegypius monachus) and
9. Bearded Vulture or Lammergeier (Gypaetus barbatus).

- Decline of vulture populations in India was first recorded at the Keoladeo Ghana National Park, Rajasthan
- The decline of Gyps genus in India has been put at 97% (over a 12 year period) by 2005.
- Similar declines have occurred in other countries in Asia, including Nepal and Pakistan.
- In India the population of three species i.e. White-backed Vulture, Slender billed Vulture and Long billed Vulture in the wild has declined drastically over the past decade.
- Red-headed vulture or king vulture, Slender billed Vulture and Long billed Vulture are listed as critically endangered.
- Populations of Egyptian vultures and White-backed Vulture have also undergone decline in India and are now classified as Endangered.
- It is initially thought the drastic decline in population was due to non-availability of food (dead livestock) or an unknown viral epidemic disease, but later on confirmed that decline in population was due to the drug diclofenac.

16.4.1. Diclofenac Sodium as the Probable Cause

- Diclofenac is a non-steroidal anti-inflammatory drug (NSAID) administered to reduce inflammation and to reduce pain in certain conditions.
- NSAIDs are associated with adverse kidney (renal) failure which is caused due to the reduction in synthesis of renal prostaglandins.
- Vultures which were unable to break down the chemical diclofenac, suffer from kidney failure when they eat the carcass of animals which have been administered with the drug - Diclofenac
- Visceral gout, an accumulation of uric acid within tissues and on the surfaces of internal organs, was observed in 85% of dead vultures found. Death caused by renal failure, which is known to occur as a result of metabolic failure or toxic disease.

- "Neck drooping" - vulture exhibit this behaviour for protracted periods over several weeks before collapsing and falling out of trees or just prior to death. It is the only obvious behavioural indication that birds are ill. Neck drooping is also reported in healthy birds under hot conditions.

16.4.2. Meloxicam - An Alternative

- Meloxicam is a second generation NSAID and rated better than Diclofenac for the treatment of livestock, with reduced risk of side effects, and is also approved for human use in more than 70 countries. Meloxicam is licensed as a veterinary drug in India, Europe and USA.

16.4.3. Banned but still in use

- The Indian Government in May 2006 banned the veterinary use of diclofenac. Unfortunately, the ban didn't reach far enough and human forms of diclofenac were used to treat sick cattle.
- One particular problem is that the human form of diclofenac is much cheaper than alternative drugs like meloxicam which have been safety tested for vultures

16.4.4. Significance of vultures in India

- Scavenging on animal carcasses of animals and thereby helping keep the environment clean;
- Disposal of dead bodies as per the religious practices of the Parsi community.
- Vultures are the primary removers of carrion in India and Africa.

16.4.5. Without vultures

- Equilibrium between populations of other scavenging species will be affected.
- Result in increase in putrefying carcasses.
- Movement of Feral dogs into carcass dumps increasing the spread of diseases such as rabies, anthrax.
- Traditional custom of the Parsis of placing their dead in the 'Towers of Silence' for vultures to feed upon will be affected.
- Life will be much harder for local hide and bone-collectors, who rely on cleaned carcasses in order to earn a living.

16.4.6. Vulture Safety Zones

- The concept of a VSZ is unique for the Asian continent but similar VSZ are in operation in both Europe and Africa.
- Aim of developing VSZs is to establish targeted awareness activities surrounding 150 km radius of vultures' colonies so that no diclofenac or the veterinary toxic drugs are found in cattle carcasses, the main food of vultures(to provide safe food).
- The VSZ is spread around in several hundred kilometers covering the Jim Corbett in Uttarakhand, Dudhwa and Kartarniaghat forest reserves in UP which is adjoining the Indo-Nepal border. Nepal has already set up VSZ on the Indian borders.

Do you know?

The Rajasthan government is said to be setting up of a captive breeding centre for the Great Indian Bustard following a proposal made by the Wildlife Institute of India.

16.4.7. VSZ's provide:

- A safe source of food that is free of contamination from veterinary drugs, poisons and other agricultural chemicals.
- Extra food close to breeding colonies, this helps to increase their breeding success by improving the survival chances of the young vultures.
- Additional food, such as bone fragments, which can be supplied to breeding birds.
- Help to reduce the risk of spreading diseases.
- A place for scientists to study the biology and ecology of these threatened species.
- An opportunity to raise public awareness on vulture conservation and to raise funds.

- An excellent opportunity for eco-tourists to observe these magnificent birds.

16.4.8. Zones

1. The zone between Uttarkhand to Nepal, which spans from Corbett to Katriya Ghat, a Tarai belt, covering 30,000 square kilometers will be earmarked as Vulture Safe zone. Slender-billed vulture and white-backed vulture are found in this area, which is marshy grassland, savannas and forests.
2. Similarly, a belt between Dibrugarh in Assam to North Lakhimpur in Arunachal Pradesh will also be conserved as a vulture safe zone where slender-billed and white-backed species of vultures are found.
3. The third zone would be in central India, covering Chhatisgarh, where white-backed and long-billed vultures are found.

16.4.9. What have to be done?

- Diclofenac free zones' (DFZ) meant the complete removal of diclofenac in the identified vulture safe zones i.e. places where vulture colonies have been identified.

16.4.10. Vulture Restaurants

- At this restaurant, tables are reserved only for the unique and rare vultures by Maharashtra and Punjab forest departments

Aim

- Conserve the fast dwindling vulture population.
- As uncontaminated food shortage is one of the reasons for vultures' decline, these scavengers will be fed by serving diclofenac free carcasses of cattle through restaurants.
- VR includes involvement of local communities in in-situ conservation, is having dual benefits to vultures and to our society.
- People inform the forest department in case of the death of an animal in their village and the department tests the dead animal for the presence of diclofenac.
- In their absence the department pays monetary benefits to the owner of the animal and informer, transports it to the vulture restaurant.
- Apart from this, whenever a vulture nesting is found, conservation measures like providing safe food near nesting trees, constant protection from all sorts of disturbances, etc., are put in place without delay.

Benefits

- Conservation of vulture from extinction
- Community participation in conservation
- Economic incentive to local cattle breeders
- Phasing out the use of diclofenac
- Awareness
- Dining spots
- Punjab - Kathlore, Chandola and Chamraur
- Maharastra – Gadchiroli, Thane, Nagpur, Nashik, Raigad districts

16.4.11. Breeding Centres in India

- Vulture Breeding and Conservation Centre had already been established at Pinjore, Haryana in 2001, and Rani, Guwahati (Assam) and another one has been established at Buxa, West Bengal in 2005. The Central Zoo Authority of India has also committed for supporting 4 such centers in the zoos at Junagadh, Bhopal, Hyderabad and Bhubhaneshwar in 2006-07.
- The Ministry of Environment and Forests (MoEF) & BNHS has taken up a program to release 30 young vultures from the breeding centre's to the demarcated safe zones at three places by year 2014.
- Though the breeding facilities had started some years back, it takes time for the reproduction amongst vultures. Young vultures take at least four to five years to fly.

16.4.12. Measures taken to Conserve Vultures

- The veterinary drug Diclofenac has been banned by Indian and Nepalese governments.
- Meloxicam, a safe alternative for vultures and other scavenging birds, is being promoted as an effective replacement.
- Government of India has formulated a National Action Plan (2006) on Vulture Conservation. The Action Plan provides for strategies, actions for containing the decline of vulture population through ex-situ, in-situ vulture conservation.
- Protection status of White backed, Long Billed and Slender Billed Vultures has been upgraded from Schedule IV to Schedule I of the Wild Life (Protection) Act, 1972.
- Vultures Safety Zone.
- Vulture Restaurant sites.
- A 'Vulture Captive Care facility' has been established at Panchkula.
- The State Governments have been advised to set up vulture care centres for the conservation of three species of vultures.
- Captive breeding centers have been established to secure healthy birds from the wild for breeding in captivity for purposes of conservation and future release.
- Awareness raising activities targeting various groups such as veterinarians, pharmacists, school children, government agencies, conservation partners and local communities are being organized regularly.
- The Ministry for Environment, Forests and Climate Change launched a Vulture Action Plan 2020-25 for the conservation of vultures in the country.

16.4.13. India'S Role in Conservation

- India moved a motion in IUCN in 2004 for vulture conservation, which was accepted in the form of the IUCN resolution which called upon Gyps vulture Range countries to begin action to prevent all uses of diclofenac in veterinary applications, and establishment of IUCN South Asian Task Force under the auspices of the IUCN and range countries to develop and implement national vulture recovery plans, including conservation breeding and release."

16.4.14. Save - Saving Asia's Vultures From Extinction.

- It's a consortium of like-minded, regional and international organizations, created to oversee and co-ordinate conservation, campaigning and fundraising activities to help the plight of south Asia's vultures.

To save three species of Gyps vulture

- Oriental white-backed vulture or White-rumped vulture
- Long-billed vulture
- Slender-billed vulture

Partners

- Bird Conservation Nepal, Bombay Natural History Society (India), International Centre for Birds of Prey (UK), National Trust for Nature Conservation (Nepal),, Royal Society for the Protection of Birds (UK)
- Asia's first 'Gyps Vulture Reintroduction Programme' launched at Pinjore. Two Himalayan Griffons were released into the wild from the Jatayu Conservation Breeding Centre, Pinjore.
- The Himalayan Griffon is closely related to the critically endangered resident Gyps species of vultures but is not endangered.

16.5. PROJECT ONE HORN RHINO

One-horned Rhinoceros is also one of the 21 species identified for Recovery programme for critically endangered species by the MoEFF & CC

Approximately 75% of the entire population of Greater One-horned Rhinoceros now occurs in India in the three States viz, Assam, Uttar Pradesh and West Bengal.

MoEFF & CC launched the "National Conservation Strategy for the Indian One-Horned Rhinoceros" with the goal to repopulate Rhinoceros population in those areas also which used to hold the Rhinoceros earlier by augmenting the existing conservation efforts and strengthening them through scientific and administrative measures.

The Ministry and the State Forest Departments of the Assam, Uttar Pradesh &West Bengal with support from other organizations are taking appropriate steps in accordance with the

New Delhi Declaration was signed after the 2nd Asian Rhino range States Conservation meeting held on February, 2019 at MoEF & CC, New Delhi wherein representatives from Bhutan, Indonesia, Malaysia and Nepal attended the meeting besides India.

Do you know?

Woolly rhino (Coelodonta antiquitatis), probably the most well known of the extinct rhinos.

16.5.1. Indian Rhino Vision 2020

- Indian rhino vision 2020 implemented by the department of environment and forests, Assam with The Bodo autonomous council as a active partner. The programme will be supported by WWF – India, WWF areas (Asian rhino and elephant action strategy) programme, the international rhino foundation (IRF), save the rhino's campaign of zoological institutions worldwide and a number of local NGOs.
- The vision of this program is to increase the total rhino foundation in Assam from about 2000 to 3000 by the year 2020 and to ensure that these rhinos are distributed over at least 7 protected areas (PA) to provide long term viability of the one-horned rhino population.

16.5.2. Why?

- Concentrating so many rhinos in a single protected area like Kaziranga exposes the species to risks of calamities (epidemics, floods, massive poaching attempts). Further, rhinos in Pabitora have exceeded carrying capacity and numbers must be reduced to protect the habitat and to mitigate the increasing rhino-human conflicts.
- Rhino species: Greater one-horned rhino (Rhinoceros unicornis)
- Activities: Anti-poaching, monitoring, translocations, community conservation.
- Translocations are the backbone of the IRV 2020 program
- The goal set was to populate the potential rhino habitat areas identified viz. Manas NP, Dibru Saikhowa WLS, Laokhowa - Bura Chapori WLS with a viable population of rhino through translocations from Kaziranga NP and Pobitora WLS.
- Manas National Park was selected as the first site for translocation of rhinos.
- Ten rhinos have been released into Manas since 2008. Ten more rhinos will be moved from Kaziranga National Park before the end of the year. Translocating rhinos will help to create a viable population of this threatened species.

Do you know?

The only endemic genus in the hotspot is the Namadapha flying squirrel which is critically endangered and is described only from a single specimen from Namdapha National Park

16.6. PROJECT SNOW LEOPARD

Snow leopard (ghost of the mountains) an elusive carnivore found in the high altitude region of 12 countries. They are India, Nepal, Bhutan, China, Mongolia, Russia, Pakistan, Afghanistan, Kyrgyzstan, Kazakhstan, Tajikistan and Uzbekistan.

In India, they inhabit the higher Himalayan and Trans- Himalayan landscape in an altitudinal range between approximately 3,000 m to 5,400 m above MSL, spanning c. 100,000 km^2 (about 5% of the global snow leopard range). They are found in the

States/UTs of Ladakh, Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunanchal Pradesh.

The cold-desert ecosystem of the Indian Trans-Himalaya also supports other unique wildlife, such as Pallas's cat, Eurasian lynx, black necked crane, Tibetan gazelle, Tibetan argali and kiang. Due to the large home range sizes of snow leopard, it's considered as the 'flagship' for conservation of the Indian Himalayas under the Government of India's Project Snow Leopard. Additionally, since snow leopards and prey occur in areas outside protected areas, the Project Snow Leopard adopted a landscape level participatory approach to snow leopard conservation, the first of its kind initiative for wildlife conservation in India

They are categorized as 'Vulnerable' by IUCN and in the Schedule I of the Indian Wildlife (Protection) Act 1972, and the J&K Wildlife (Protection) Act 1978. They are listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS), affording the highest conservation status to the species, both globally and in India.

In India, snow leopard is threatened by prey depletion due to excessive livestock grazing, retribution killing, poaching, illegal trade, unregulated tourism, climate change, infrastructure development in the mountains and poor waste management practices leading to increase in free-ranging dog populations.

Global protocol for the Population Assessment of World's Snow Leopards (PAWS) is under the Global Snow Leopard Ecosystem Protection Program (GSLEP)

- India has ratified, in 2013, and played an important role in the Global Snow Leopard and Ecosystem Protection Program (GSLEP), a high level inter-governmental alliance of all the 12 snow leopard range countries. These Governments have jointly initiated an effort to conduct Population Assessment of the World's Snow Leopards, or PAWS.
- Recognizing the importance of understanding snow leopard occurrence and status for conservation planning, the Government of India has launched India's PAWS effort, referred to here as the 'Snow Leopard Population Assessment in India (SPAI)', which is expected to lead to scientifically robust national and state-wise population estimates of this endangeredand elusive cat across its high altitude habitat, both inside and outside protected areas.
- Snow Leopards are not restricted to protected areas but spread across the high elevations Himalayan and Trans- Himalayan regions.
- GoI hosted the 4th Steering Committee of the GSLEP program in October 2019 at New Delhi. This meeting resulted in the "New Delhi Statement" of strengthening the resolve of the snow leopard range countries towards conservation of the mountain ecosystems of Central and South Asia.

Snow Leopard Population Assessment of India–

- SLPAI is the First National Protocol to Enumerate Snow Leopard Population in India for first time
- SLPAI is a two-step process of field surveys implemented simultaneously at the state level, for snow leopard population assessment.
- Step 1 - systematically assess the spatial distribution of snow leopards (as a function of habitat covariates). This occupancy-based approach based on data on sign and interview surveys and field and geospatial mapping would lead to a refined snow leopard distribution map.
- Step 2 - snow leopard abundance can be estimated through camera trapping and genetics in habitat patches (> 500 sq. km) of low and high quality, as a function of heterogeneous density across space.
- The results from the first step would inform and help improve the design of the second step.
- Under SPAI, assessments of the population of wild ungulates (prey species) such as blue sheep, ibex,

argali and others will also be undertaken in specific locations. The survey will also do undertake Situation Description of the ecosystem and Assessment of Threats

India now has 12,852 leopards as compared to the previous estimate of 7910 conducted 2014. More than 60% increase in population has been recorded. The States of Madhya Pradesh, Karnataka and Maharashtra recorded the highest leopard estimates respectively.

16.6.1. Project Snow Leopard - Jan 2009

- The Project Snow Leopard is an Indian initiative for strengthening wildlife conservation in the Himalayan high altitudes.

[illegible] promote a knowledge-based and adaptive conservation framework that fully involves the local communities, who share the snow leopard's range, in conservation efforts.

Goal:

- To safeguard and conserve India's unique natural heritage of high altitude wildlife populations and their habitats by promoting conservation through participatory policies and actions.

Location:

- All biologically important landscapes in the Himalayan high altitudes in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh.
- Project Snow Leopard is designed for all biologically important habitats within the snow leopard's range, irrespective of their ownership (e.g. Protected Areas, common land, etc.).
- Forming an estimated 1,29,000 km² within India, these areas generally comprise the non-forested or sparsely-forested high altitude regions of the Himalaya and Trans-Himalaya above elevations of 3,000 m in the Western Himalaya and above 4,000m in the eastern Himalaya.

16.6.2. Why to conserve the high altitude ecosystem?

- The high altitudes of India (> 3000 m. to 130,000 km², including the Himalaya and Trans-Himalaya biogeographic zones) support a unique wildlife assemblage of global conservation importance.
- This includes highly endangered populations of species such as the snow leopard, two species of bears, wolf, red panda, mountain ungulates such as the wild yak, chiru, Tibetan gazelle, Tibetan argali, Ladakh urial, two species of musk deer, the hangul, three species of goral, serow, and takin, etc. High altitude lakes and bogs provide breeding grounds for a variety of avifauna including the black-necked crane, barheaded Geese, brahminy ducks, and brown-headed gulls, etc.
- India has ratified international agreements promoting the conservation of high altitude wildlife species such as the snow leopard.
- In 2003, the Convention on Migratory Species included the snow leopard as a Concerted Action Species under its Appendix I.
- Similarly, in 2003, the Convention on International Trade in Endangered Species (CITES) expanded the scope of the CITES Tiger Enforcement Task Force to include all Asian big cat species including the snow leopard.
- In both cases, representatives of the MoEF played a vital role in elevating the conservation prominence of the snow leopard internationally.
- Each state will select one biologically important site and develop a science-based, participatory conservation programme in that site in the first five years of Project Snow Leopard. This will be subsequently expanded to include other biologically important sites.

16.7 SECURE HIMALAYA

- The project was launched by the MoEF&CC in collaboration with UNDP. The plan intends to conserve the snow leopards by protecting their habitats and improve the ecology of Himalayan ranges and lives of the mountain communities. It covers Himachal Pradesh, Jammu and Kashmir, Uttarakhand and Sikkim.

Focus areas

1. Strengthening and improving protected area network
2. Landscape-level approach for wildlife conservation
3. Control of poaching and illegal trade in wildlife
4. Mitigation of human-wildlife conflicts and
5. Management of tourism in wildlife areas

16.8. PROJECT CHEETAH

Project Cheetah is the world's first intercontinental large carnivore translocation programme, conducted as part of India's conservation program 'Project Tiger.'

In 1952, the cheetah was declared extinct in India, making it the sole large wild mammal species to have gone extinct since the country gained independence in 1947. This extinction can be attributed to several factors, including the widespread capture of animals for activities like coursing, bounties and sport hunting, extensive habitat conversion, and a significant decline in the cheetah's prey population.

Objectives

- Action Plan aims to establish viable cheetah metapopulation in India that allows the cheetah to perform its functional role as a top predator and provides space for the expansion of the cheetah within its historical range thereby contributing to its global conservation efforts.
- It also aims to introduce at least 50 cheetahs into various national parks over the next five years

Cheetah reintroduction plan

- Under the umbrella of Project Cheetah, Kuno National Park in Madhya Pradesh recently welcomed eight African Cheetahs, consisting of five females and three males, all originating from Namibia.
- The other sites recommended for holding and conservation breeding of cheetah in India, in controlled wild conditions are:
  - Nauradehi Wildlife Sanctuary, Madhya Pradesh
  - Gandhi Sagar Wildlife Sanctuary - Bhainsrorgarh Wildlife Sanctuary complex, Madhya Pradesh
  - Shahgarh bulge in Jaisalmer, Rajasthan.
  - Mukundara Tiger Reserve,Rajasthan.

Significance

The significance of relocating cheetahs lies in its potential to:

- **Create a Sustainable Cheetah Population in India:** The relocation aims to establish a thriving cheetah population that can interconnect and persist over time.
- **Mobilize Resources:** This project requires funding and resources, which can galvanize efforts for wildlife conservation and generate employment opportunities.
- **Global Conservation Contribution:** By reintroducing cheetahs, India participates in worldwide conservation, aiding the preservation of this endangered species.
- **Boosting Local Livelihoods:** Wildlife tourism and conservation initiatives can improve the income and livelihoods of local communities, garnering their support for conservation.
- **Contribute to Climate Goals:** A balanced ecosystem with cheetahs as apex predators can help mitigate the impacts of climate change.

Therefore, the cheetah relocation holds significance through biodiversity conservation, community development, and climate change mitigation.

16.9. SEA TURTLE PROJECT

Five species of sea turtles are found in Indian coastal waters. They are the Olive ridley, Green, Hawksbill, Leatherback and Loggerhead and are protected under Schedule I of the Wildlife (Protection) Act, 1972. Except Loggerhead turtles, the remaining four species nest along the Indian coastline and islands of India. Sea turtles are an indicator of healthy marine ecosystems and provide a source of revenue for local communities through tourism.

Threats faced by sea turtles in india

- Onshore threats

1 loss of nesting beach

  - Natural causes due to erosion, shifting sands, Ipomoea invasion, cyclones, global warming and climate change
  - Anthropogenic causes due to Casuarina plantations, sand mining

2 coastal development - Disturbance and loss of nesting beaches due to construction of ports, jetties, resorts, industries,etc

3 pollution – light pollution and Marine plastic debris and pollution caused due to construction of ports, fish landings, resorts or tourism activities on or near the beach

4 Nest predation by wild predators like jackals, wild pigs, etc. as well as by the feral and domesticated dogs

- Offshore threats

1 fishing related mortality - Bycatch due to near shore fishing, trawling, gill netting

2 Offfshore Oil Explorations - Destruction of habitat, oil spills, disturbance due to excessive movement of vessels

3 pollution - Plastics, Oil spills, discharge from coastal industries and sewage

4 disease - Fibropapillomatosis (external tumors) caused by water pollution

16.9.1 Sea Turtle Project

- A significant proportion of world's Olive Ridley Turtle population migrates every winter to Indian coastal waters for nesting mainly at eastern coast.
- With the objective of conservation of olive ridley turtles and other endangered marine turtles, Ministry of Environment & Forests initiated the Sea Turtle Conservation Project in collaboration of UNDP in November, 1999 with Wildlife Institute of India, Dehradun as the Implementing Agency.
- The project is being implemented in 10 coastal States of the country with special emphasis in State of Orissa.
- The project has helped in preparation of inventory map of breeding sites of Sea Turtles, identification of nesting and breeding habitats along the shore line, and migratory routes taken by Sea Turtles, development of guidelines to safeguard and minimize turtle mortality, development of national and international cooperative and collaborative action for Sea Turtle Conservation, developing guideline plans for tourism in sea turtle areas and developing infrastructure and human resources for Sea Turtle Conservation.
- One of the important achievements have been demonstration of use of Satellite Telemetry to locate the migratory route of Olive Ridley Turtles in the sea and sensitizing the fishermen and State Government for the use of Turtle Exclusion Device (TED) in fishing trawlers to check turtle mortality in fishing net.

16.9.2. National Marine Turtle Action Plan (2021 - 26)

Aims to conserve marine turtles, associated species and their habitats for maintaining a healthy marine ecosystem.

- The action plan is proposed to be adopted at the National and State Government level with following objectives

1. reduce direct and indirect cause of marine turtle mortality
2. protect, Conserve and rehabilitate marine turtle habitats

3. Improve the understanding of marine turtles and their habitats, through a research, monitoring and information exchange;
4. Promote public Awareness and Education on conservation of marine turtles and their habitats;
5. Enhance livelihoods of coastal communities through promoting sustainable ecotourism;
6. Enhance national, regional and international cooperation on marine turtle conservation.
7. To strengthen law enforcement activities

16.10. INDIAN CROCODILE CONSERVATION PROJECT

- The Indian Crocodile Conservation Project has pulled back the once threatened crocodilians from the brink of extinction and place them on a good path of recovery. The Project has not just produced a large number of crocodiles, but has contributed towards conservation in a number of related fields as well.

Objectives:

- To protect the remaining population of crocodilians in their natural habitat by creating sanctuaries.
- To rebuild natural population quickly through `grow and release' or `rear and release' technique - more than seven thousand crocodiles have been restocked - about 4000 gharial (Gavialis gangeticus), 1800 mugger (Crocodylus palustris) and 1500 salt- water crocodiles (Crocodylus porosus)
- To promote captive breeding,
- To take-up research to improve management.
- To build up a level of trained personnel for better continuity of the project through training imparted at project-sites and through the (erstwhile) Central Crocodile Breeding and Management Training Institute, Hyderabad.
- To involve the local people in the project intimately .

16.11. PROJECT HANGUL

- The Kashmir stag (Cervus affinis hanglu) also called Hangul is a subspecies of Central Asian Red Deer native to northern India.
- It is the state animal of jammu & kasmir
- This deer lives in groups of two to 18 individuals in dense riverine forests, high valleys, and mountains of the Kashmir valley and northern Chamba in Himachal Pradesh.
- In Kashmir, it's found in Dachigam National Park at elevations of 3,035 meters.
- These deer once numbered from about 5,000 animals in the beginning of the 20th century. Unfortunately, they were threatened, due to habitat destruction, over-grazing by domestic livestock and poaching.
- This dwindled to as low as 150 animals by 1970. However, the state of Jammu & Kashmir, along with the IUCN and the WWF prepared a project for the protection of these animals. It became known as Project Hangul. This brought great results and the population increased to over 340 by 1980.

16.12. CAPTIVE BREEDING

- Captive breeding means that members of a wild species are captured, then bred and raised in a special facility under the care of wildlife biologists and other expert.
- Bringing an animal into captivity may represent the last chance to preserve a species in the wild in these situations:
- When a population drops dangerously, captive breeding can boost numbers. Captive-produced young can sometimes be released into the wild where populations have diminished or disappeared, yet where suitable habitat remains to support them.
- When all of the existing habitat is poor quality or other environmental problems occur, a captive population can be maintained until the problems

can be solved or another appropriate habitat can be found for the animal in the wild.

- When the existing habitat is fragmented, captive breeding combined with management may provide the only hope for survival by providing opportunities for genetic mixing.
- When a group of birds stays in one area of degraded habitat because they are behaviorally trapped, captive breeding and release programs can help them to expand their range.
- By holding and breeding birds in captivity we acquire knowledge about them that may be difficult or impossible to accomplish in the wild. Sometimes this scientific research provides some of the information necessary to save a species.
- If situation demands reintroduction or reestablishment in the natural habitat may also arise.
- E.g. captive breeding of lion tailed macaque in Arignar Anna Zoological Park, Chennai and in mysore zoo.

16.13. PROJECT DOLPHIN

- Dolphins are animals of aquatic ecosystems. They are found in the sea, brackish water and fresh water. A total of 15 species of marine and harbour dolphins have been reported from Indian waters and coasts. Besides, the Irrawady Dolphins are found in brackish waters of Odisha. Amongst the fresh water dolphins, the Gangetic Dolphin is found in the Ganges river and its tributaries. Apart from this, Indus River Dolphins have also been reported in Indus River in Punjab.
- All fresh water, brackish water and marine Dolphins (Cetaceans) are listed in Schedule-I of the Wild Life (Protection) Act, 1972, thereby according them the highest degree of protection against hunting.
- Gangetic Dolphin is one of the 17 species identified for taking up 'Recovery programme of Critically Endangered Species, under the Centrally Sponsored Scheme of 'Integrated Development of Wildlife Habitat'
- National Mission for Clean Ganga (NMCG) has initiated dolphin conservation programme in 2016 to ensure long term survival of dolphin and other river fauna.

Do you know?

India's first dugong conservation reserve created in palk bay, Tamil Nadu. In India, dugongs are found in Palk Bay, Gulf of Mannar in Tamil Nadu, Gulf of Kutch in Gujarat and Andaman and Nicobar islands.

16.13.1. Ganges Dolphin

- The Ministry of Environment and Forests notified the Ganges River Dolphin as the National Aquatic Animal.
- the Gangetic dolphin has been notified by the Assam government as the state aquatic animal
- It can survive only in freshwater and is essentially blind. This mammal hunts by emitting ultrasonic sounds, which bounce off fish and other prey, enabling it to "see" an image in its mind.
- As per assessment reports available with the environment ministry, there are about 3,700 Ganges River Dolphins in Indian rivers, of which Uttar Pradesh has highest. In India, they are sighted in the deep rivers of Assam, Bihar, Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal.
- the Conservation Action Plan for the Gangetic Dolphin (2010-2020) launched by MoEF & CC identified threats to Gangetic dolphins and the impact of river traffic, irrigation canals and depletion of prey-base on dolphin populations.
- The River Dolphin inhabits the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, and Bangladesh.
- It is estimated that their total population is around 2,000 and they are listed in Schedule I of the Wildlife Protection Act (1972).

- The Ganges Dolphin is among the four "obligate" freshwater dolphins found in the world – the other three are the 'baiji' found in the Yangtze River (China), the 'bhulan' of the Indus (Pakistan) and the 'boto' of the Amazon River (Latin America).
- Although there are several species of marine dolphins whose ranges include some freshwater habitats, these four species live only in rivers and lakes.
- The Chinese River Dolphin was declared functionally extinct by a team of international scientists in 2006.
- In India, the Ganges River Dolphin is threatened by river water pollution and siltation, accidental entanglement in fishing nets and poaching for their oil.
- In addition, alterations to the rivers in the form of barrages and dams are separating populations. Various organizations, including the WWF-India in Uttar Pradesh have initiated programs for conservation and re-introduction of the River Dolphin.

16.13.2. Conservation efforts-Project Dolphin

- MoEF&CC will launch the 10-year project to give impetus to conserving and protecting the fast-depleting species of both river and sea dolphins, and "strengthen biodiversity, create employment opportunities and attract tourism".
- It envisages addressing concerns over conservation and empowering stakeholders, such as the river-dependent population, in reducing river pollution and allowing for sustainable fishery and other river-based livelihood options through scientific conservation methods.
- "The project will involve conservation of dolphins and the overall aquatic habitat through the use of modern technology, especially in enumeration and anti-poaching activities. It will engage fishermen and other river and ocean dependent population, and strive for improving the livelihood of local communities."
- National Dolphin Research Centre (NDRC) is being established on the premises of Patna University for the conservation of the endangered Gangetic river dolphin.
- Vikramshila Ganges Dolphin Sanctuary has been established in Bihar.

16.14 GOVERNMENT MEASURES TAKEN TO PREVENT THE MENACE OF WILD ANIMAL'S ENTRY TO HUMAN HABITATS

- Financial assistance is provided to the State Governments under the Centrally Sponsored Schemes, viz., 'Integrated Development of Wildlife Habitats', 'Project Tiger' and 'Project Elephant' for improvement of forest and wildlife areas like the national parks and sanctuaries to augment food and water availability in forests which can reduce migration of animals from forests to the habitations.
- Construction of barriers like boundary walls and solar-powered electric fences around the sensitive areas to prevent the wild animal attacks. These activities are also permissible under the Central assistance.
- Development of necessary infrastructure and support facilities for immobilization of the identified problematic animals through tranquilization, and their relocation to the natural habitat or rehabilitation in rescue centers.
- The Chief Wildlife Wardens of the States/Union Territories are empowered to permit hunting of problematic animals under the provisions of the Wildlife (Protection) Act, 1972.
- Programmes are launched to sensitize people and create awareness about the Do`s and Don'ts in case of scare and attacks of wild animals.
- Eco-development activities are undertaken in villages around Protected Areas to elicit the cooperation of communities in management of the

Protected Areas, which includes actions to address the grievances of people regarding human-wildlife conflicts.

Do you know?

Nothing specified in wildlife protection act 1972, shall affect the hunting rights conferred on the Scheduled Tribes of the Nicobar Islands in the Union territory of Andaman and Nicobar Islands.

16.15. INDIA ADOPTS SAWEN

- India has adopted the Statute of the South Asia Wildlife Enforcement Network (SAWEN) sand becoming its formal member in order to strengthen ties with the member countries in controlling the trans-boundary wildlife crime through communication, coordination, collaboration, capacity building and cooperation in the region.
- SAWEN, a Regional network is comprised of eight countries in South Asia: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. It aims at working as a strong regional inter governmental body for combating wildlife crime by attempting common goals and approaches for combating illegal trade in the region.

16.16. NATIONAL WILDLIFE ACTION PLAN

- The first National Wildlife Action Plan (NWAP) was adopted in 1983, based upon the decision taken in the XV meeting of the Indian Board for Wildlife held in 1982. The plan had outlined the strategies and action points for wildlife conservation which are still relevant.
- In the meanwhile, however, some problems have become more acute and new concerns have become apparent, requiring a change in priorities. Increased commercial use of natural resources, continued growth of human and livestock populations and changes in consumption patterns are causing greater demographic impacts. Biodiversity conservation has thus become a focus of interest. The National Forest Policy was also formulated in 1988, giving primacy to conservation.
- The first National Wildlife Action Plan (NWAP) of 1983 has been revised and the Wildlife Action Plan (2002-2016) was adopted before.
- India presented the third National Wildlife Action Plan for 2017-2031, outlining the future path for wildlife conservation. The third action plan follows the first in 1983 and the second from 2002 to 2016. The third National Wildlife Action Plan is noteworthy in that it is the first time India has acknowledged the concerns about climate change's impact on wildlife and emphasized the importance of including activities needed for mitigation and adaptation into wildlife management planning procedures.

National Wildlife Action Plan for 2017-2031

Components:

- Enhancing and advancing integrated management of wildlife and their habitats.
- Addressing climate change and advocating for sustainable management of aquatic biodiversity in India.
- Promoting ecotourism, nature education, and participatory management.
- Reinforcing wildlife research, human resource development in wildlife conservation.
- Providing the necessary policies and resources for wildlife conservation in India. This plan will facilitate the integration of wildlife conservation into development planning processes.

Strategy for action

- The strategy is founded on the assumption that ecosystem-governed or tightly controlled natural processes are critical for food production, health, and other elements of human survival and sustainable development.
- It also highlights the intrinsic value of nature and its various components. The preservation of these

ecosystems, known as the 'Life Support System,' is seen as critical for all societies, regardless of their degree of development.

- It also highlights two additional elements of environmental conservation: the preservation of genetic variation and the sustainable use of species and ecosystems, both of which have a direct impact on scientific progress and the support of millions of rural populations.
- The plan takes a landscape approach to the conservation of all species, i.e. uncultivated flora and animals of ecological value to the environment and to people, regardless of where they exist.
- It prioritizes the recovery of vulnerable wildlife species while protecting their habitats, which include terrestrial, inland aquatic, coastal, and marine ecosystems.
- It emphasizes the fact that, despite being one of the world's 17 mega biodiversity countries, national planning has not taken seriously the detrimental ecological repercussions of population, commerce, and development pressures on wilderness regions.
- It underlines the fact that despite being one of 17 mega biodiversity countries of the world, national planning has not taken serious note of adverse ecological consequences of reduction and degradation of wilderness areas from the pressures of population, commercialization and development projects.
- As a result, the plan has highlighted the catastrophic deterioration of our natural heritage, which includes rivers, forests, grasslands, mountains, wetlands, coastal and marine ecosystems, dry areas, and deserts.
- The plan emphasizes the growing need for public support for wildlife conservation and, to that end, recommends strengthening the 'core-buffer-multi use surround' structure with increased investments in eco-development, education, innovation, training, extension, conservation awareness, and outreach programmes.
- This strategy gives enough attention to wildlife health and catastrophe management.
- Tourism management in wildlife regions, including a plough-back mechanism, human resource development, and staff welfare, has been reoriented in the strategy.
- The strategy calls for communities living in forest lands and other wilderness regions to be treated fairly under the Forest Rights Act, notwithstanding their limited resources and reliance on natural biomass supplies.

16.17. DNA BARCODING

a MoU signed between Zoological Survey of India (ZSI), a subordinate organization under MoEF&CC and International Barcode of Life (iBOL), a Canadian not-for-profit corporation.

ZSI and iBOL have come together for further efforts in DNA barcoding, a methodology for rapidly and accurately identifying species by sequencing a short segment of standardized gene regions and comparing individual sequences to a reference database.

iBOL is a research alliance involving nations that have committed both human and financial resources to enable expansion of the global reference database, the development of informatics platforms, and/or the analytical protocols needed to use the reference library to inventory, assess, and describe biodiversity.

The MoU will enable ZSI to participate at the Global level programmes like Bioscan and Planetary Biodiversity Mission.

16.17.1. Programs of iBOL

BARCODE 500K, completed in 2015, was the *foundation* that established the sequencing facilities, analytical protocols, informatics platforms, and international collaboration needed to build the DNA barcode reference libraries. Building on this success, **BIOSCAN** launched in June 2019 with an intent to complete by 2026 to scan life and codify species interactions while expanding the reference library and demonstrating its utility. BIOSCAN will be the foundation for the **Planetary Biodiversity Mission,** a mission to save our living planet will n=be launched in 2026 and completed by 2045.

BARCODE 500K

Goals:

- Deliver DNA barcode coverage for 0.5 million species.
- Develop the informatics platform and analytical protocols required for the development of the DNA barcode reference library.
- Establish a core facility to provide sequencing and informatics support.

16.17.2. BIOSCAN

Goals:

- Deliver DNA barcode coverage for 2 million species.
- Activate biomonitoring for one or more ecoregions in each participating nation & codify species interactions for these sites.
- Develop informatics support for high-throughput sequencing.
- Promote applications of DNA barcoding.

16.17.3. Planetary Biodiversity Mission

Goals:

- Complete the census of all multicellular species.
- Establish a global biosurveillance program.
- Construct a 'library of life' by preserving DNA extracts from all species.

16.18. CONSERVATION CLASSIFICATION OF SPECIES

Flagship species

- A flagship species is a species chosen to represent an environmental cause, such as an ecosystem in need of conservation. These species are chosen for their vulnerability, attractiveness or distinctiveness in order to engender support and acknowledgement from the public at large. Thus, the concept of a flagship species holds that, by giving publicity to a few key species, the support given to those species will successfully leverage conservation of entire ecosystems are all species contained therein.
- Example: Indian tiger, African elephant, giant panda of China, mountain gorilla of Central Africa, orangutan of Southeast Asia and the leatherback sea turtle.

Charismatic megafauna

- These are large animal species with widespread popular appeal that environmental activists use to achieve conservation goals well beyond just those species. Examples include the Giant Panda, the Bengal Tiger, and the Blue Whale.

Umbrella species

- Umbrella species is a wide-ranging species whose requirements include those of many other species. The protection of umbrella species automatically extends protection to other species. These are species selected for making conservation related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.

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CHAPTER - 17

CLIMATE CHANGE

Climate is the long-term average of a region's weather events. The Earth's climate is not static. Over the billions of years of earth's existence, it has changed many times in response to natural causes like sun spot, ice age glaciations, etc.

"Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

However, when today people talk about 'climate change', they mean the changes in climate over the last 100 years which is caused predominantly by human activity.

The phrase 'climate change' represents a change in the long-term weather patterns. Climate change is not a change of weather in a particular day; it is the cumulative change of long term weather pattern i.e. changes in climate. For example, it's possible that a winter day in Jammu, could be sunny and mild, but the average weather, the climate, tells us that Jammu's winters will mainly be cold and include snow and rain. The change in the pattern of Jammu's winters from the normal winter pattern represents an epitome of climate change.

Climate change is the measurable effects of the continual warming trend. Climate change is usually measured in major shifts in temperature, rainfall, snow, and wind patterns lasting decades or more.

Humans are creating climate change by burning large amounts of fossil fuels (coal, oil, natural gas), deforestation (when forests are cut down or burned, they can no longer store carbon, and the carbon is released to the atmosphere).

17.1. GLOBAL WARMING

Earth has warmed at an unprecedented rate over the last hundred years and particularly over the last two decades. Since 1992, each year has been one of the warmest years on record. 2016 was the hottest year on record, worldwide. An upsurge in the amount of extreme weather events, such as wildfires, heat waves, and strong tropical storms, is also attributed

"Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities."

17.1.1. Global Warming - Impacts

- Rise in Sea level
- Changes in rainfall patterns.
- Increased likelihood of extreme events such as heat wave, flooding, hurricanes, etc.
- Melting of the ice caps.
- Melting of glaciers.

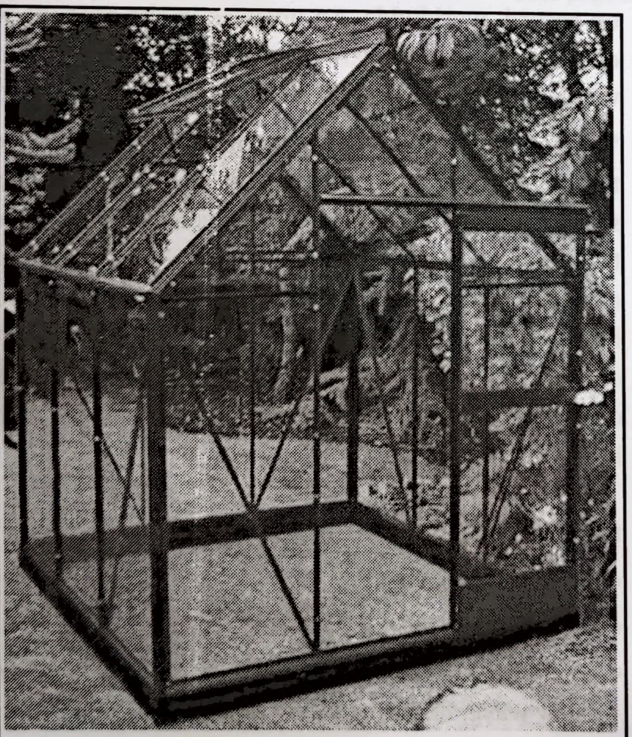
- Widespread vanishing of animal populations due to habitat loss.
- Spread of disease (like malaria, etc).
- Bleaching of Coral Reefs.
- Loss of Plankton due to warming of seas.

17.2. GREENHOUSE EFFECT

The greenhouse effect is a naturally occurring phenomenon that blankets the earth lower atmosphere and warms it, maintaining the temperature suitable for living things to survive.

Just as greenhouses, that keeps the air warm inside its chamber, water vapor and green house gases warms the Earth. Greenhouse gases play an important role in the balance of Earth's cooling and warming.

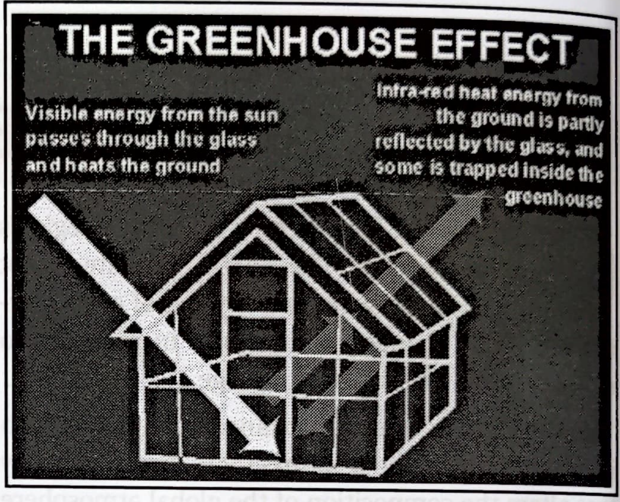
According to one estimate, in the absence of naturally occurring green house effect, the average temperature of the earth surface would be -19°C instead of present value of 15°C and the earth would be a frozen lifeless planet.



Green House

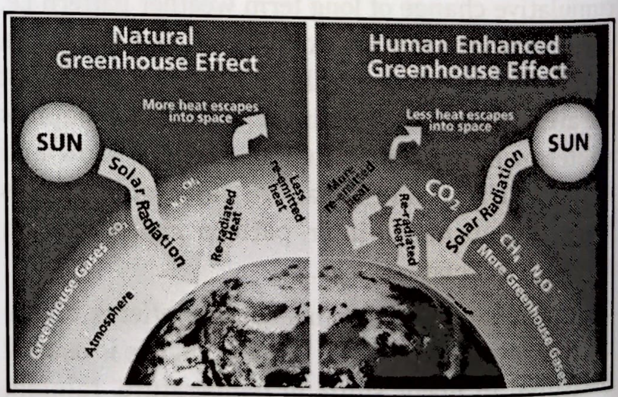
A greenhouse/ glasshouse is a building made of glass chambers in which plants are grown in cold countries or in cold climate areas. There is a continued increase in temperature in green house even when the outside temperature remained low. It protects plants from frost.

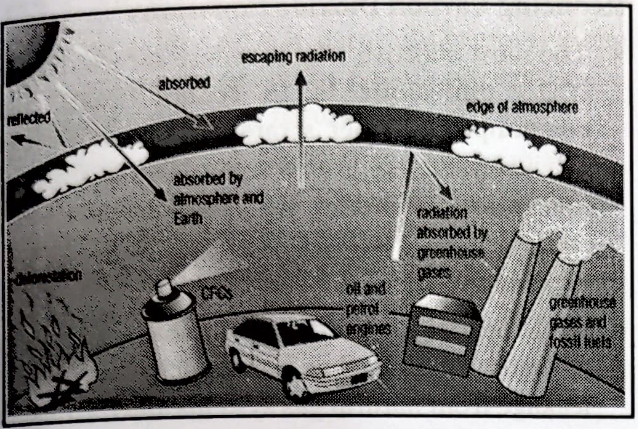
17.2.1. What is the Greenhouse Effect?


THE GREENHOUSE EFFECT
Visible energy from the sun passes through the glass and heats the ground
Infra-red heat energy from the ground is partly reflected by the glass, and some is trapped inside the greenhouse

The greenhouse effect is a process (similar to green house) caused by greenhouse gases, which occur naturally in the atmosphere. This process plays a crucial role in warming the Earth's surface, making it habitable.

However, human-generated greenhouse gas emissions upset the natural balance and lead to increased warmth.




escaping radiation
absorbed
reflected
edge of atmosphere
absorbed by atmosphere and Earth
radiation absorbed by greenhouse gases
deforestation
CFCs
oil and petrol engines
greenhouse gases and fossil fuels

Incoming Energy

- The Sun emits energy that is transmitted to Earth. Because the Sun is very hot, the energy is emitted in high-energy short wavelengths that penetrate the Earth's atmosphere.

Absorption

- About 30% of the Sun's energy is reflected directly back into space by the atmosphere, clouds, and surface of the Earth. The rest of the Sun's energy is absorbed into the Earth's system.

Emission

- The Earth re-emits energy back into the atmosphere. Because the Earth is cooler than the Sun, the energy is emitted in the form of infrared radiation, at wavelengths longer than the incoming solar energy.

Role of Greenhouse Gases

- Greenhouse gases in the atmosphere absorb much of the long-wave energy (infrared radiation) emitted from the Earth's surface, preventing it from escaping from the Earth's system. The greenhouse gases then re-emit this energy in all directions, warming the Earth's surface and lower atmosphere.

Human Role

- The atmospheric concentration of greenhouse gases has increased significantly over the past two centuries, largely due to human-generated carbon dioxide emissions from burning fossil fuels, deforestation.
- This increase has amplified the natural greenhouse effect by trapping more of the energy emitted by the Earth. This change causes Earth's surface temperature to increase.

17.3. GREEN HOUSE GASES

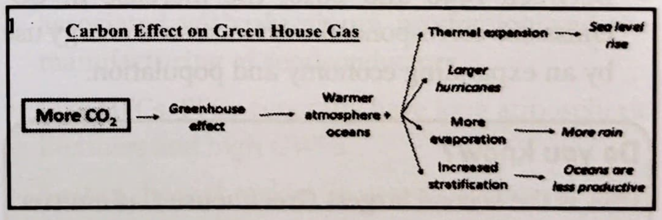
- Greenhouse gases means those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorbs and re-emit infrared radiation.

17.3.1. Water vapour

Water vapour is the biggest overall contributor to the greenhouse effect and humans are not directly responsible for emitting this gas in quantities sufficient to change its concentration in the atmosphere. However, CO_2 and other greenhouse gases is increasing the amount of water vapour in the air by boosting the rate of evaporation.

Unlike CO_2, which can persist in the air for centuries, water vapour cycles through the atmosphere quickly, evaporating from the oceans and elsewhere before coming back down as rain or snow.

Since the rate of evaporation rises with temperature, the amount of water vapour in the air at any one time (and the amount of warming it causes) is strongly related to the amount of other greenhouse gases in the air.



17.3.2 Carbon Dioxide

- Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities. Carbon dioxide is naturally present in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals).

- Human activities are altering the carbon cycle both by adding more CO_2 to the atmosphere and by reducing the natural sinks, like deforestation, to remove CO_2 from the atmosphere.
- While CO_2 emissions come from a variety of natural sources, human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution.

The main sources

i. The combustion of fossil fuels to generate electricity.

ii. The combustion of fossil fuels such as gasoline and diesel used for transportation.

iii. Many industrial processes emit CO_2 through fossil fuel combustion.

iv. Several processes also produce CO_2 emissions through chemical reactions that do not involve combustion, for example, the production and consumption of mineral products such as cement, the production of metals such as iron and steel, and the production of chemicals, etc.

Emissions and Trends

- Changes in CO_2 emissions from fossil fuel combustion are influenced by many factors, including population growth, economic growth, changing energy prices, new technologies, changing behavior, and seasonal temperatures.
- Between 1990 and 2010, the increase in CO_2 emissions corresponded with increased energy use by an expanding economy and population.

Do you know?

USA is the second largest Greenhouse Gas emitter presently. However, if cumulative historical emission is considered, USA would be a largest GHG emitter. So, its withdrawal will affect control of cumulative global GHG emissions. It will also affect the availability of international funds for climate change, as USA was a contributor to climate finance.

Reducing Carbon Dioxide Emissions

- The most effective way to reduce carbon dioxide (CO_2) emissions is to reduce fossil fuel consumption. Other strategies include Energy Efficiency, Energy Conservation, Carbon Capture and Sequestration.

17.3.3. Methane

- Methane (CH_4) is emitted by natural sources such as wetlands, as well as human activities such as leakage from natural gas systems and the raising of livestock.
- Natural processes in soil and chemical reactions in the atmosphere help remove CH_4 from the atmosphere.

Sources

Natural sources:

- Wetlands are the largest source, emitting CH_4 from bacteria that decompose organic materials in the absence of oxygen.
- Smaller sources include termites, oceans, sediments, volcanoes, and wildfires.

Human induced:

- Agriculture: Domestic livestock such as cattle, buffalo, sheep, goats, and camels produce large amounts of CH_4 as part of their normal digestive process. Also, when animals' manure is stored or managed in lagoons or holding tanks, CH_4 is produced. Because humans raise these animals for food, the emissions are considered human-related. Globally, the Agriculture sector is the primary source of CH_4 emissions
- Industry: Methane is the primary component of natural gas. Some amount of CH_4 is emitted to the atmosphere during the production, processing, storage, transmission, and distribution of crude oil & natural gas.
- Waste from Homes and Businesses: Methane is generated in landfills as waste decomposes and from the treatment of wastewater.

17.3.4. Nitrous Oxide

- Nitrous oxide (N_2O) is naturally present in the atmosphere as part of the Earth's nitrogen cycle, and has a variety of natural sources.
- However, human activities such as agriculture, fossil fuel combustion, wastewater management, and industrial processes are increasing the amount of N_2O in the atmosphere.

Sources

Natural sources:

- Natural emissions of N_2O are mainly from bacteria breaking down nitrogen in soils and the oceans.

Human induced:

- Agriculture. Nitrous oxide is emitted when people add nitrogen to the soil through the use of synthetic fertilizers. Nitrous oxide is also emitted during the breakdown of nitrogen in livestock manure and urine, which contributed to 6% of N_2O emissions in 2010.
- Transportation. Nitrous oxide is emitted when transportation fuels are burned.
- Industry. Nitrous oxide is generated as a byproduct during the production of nitric acid, which is used to make synthetic commercial fertilizer, and in the production of adipic acid, which is used to make fibers, like nylon, and other synthetic products.
- Removal: Nitrous oxide is removed from the atmosphere when it is absorbed by certain types of bacteria or destroyed by ultraviolet radiation or chemical reactions.

17.3.5. Fluorinated Gases

- They are emitted through a variety of industrial processes such as aluminum and semiconductor manufacturing & Substitution for Ozone-Depleting Substances.
- Many fluorinated gases have very high global warming potentials (GWPs) relative to other greenhouse gases. Fluorinated gases are well-mixed in the atmosphere, spreading around the world after they're emitted.
- Fluorinated gases are removed from the atmosphere only when they are destroyed by sunlight in the far upper atmosphere. In general, fluorinated gases are the most potent and longest lasting type of greenhouse gases emitted by human activities.
- There are three main categories of fluorinated gases—
  1. hydrofluorocarbons (HFCs),
  2. perfluorocarbons (PFCs), and
  3. sulfur hexafluoride (SF6).

Substitution for Ozone-Depleting Substances:

- Hydrofluorocarbons are used as refrigerants, aerosol propellants, solvents, and fire retardants. These chemicals were developed as a replacement for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) because they do not deplete the stratospheric ozone layer.
- Unfortunately, HFCs are potent greenhouse gases with long atmospheric lifetimes and high GWPs, and they are released into the atmosphere through leaks, servicing, and disposal of equipment in which they are used.

Industry:

- Perfluorocarbons are compounds produced as a by-product of various industrial processes associated with aluminum production and the manufacturing of semiconductors.
- Like HFCs, PFCs generally have long atmospheric lifetimes and high GWPs.
- Sulfur hexafluoride is used in magnesium processing and semiconductor manufacturing, as well as a tracer gas for leak detection. HFC-23 is produced as a by-product of HCFC-22 production.

Transmission and Distribution of Electricity:

- Sulfur hexafluoride is used in electrical transmission equipment, including circuit breakers.

17.3.6. Black Carbon

- Black carbon (BC) is a solid particle or aerosol, (though not a gas) contributes to warming of the atmosphere.
- Black carbon, commonly known as soot, is a form of particulate air pollutant, produced from incomplete combustion. It consists of pure carbon in several linked forms.

Sources

- biomass burning,
- cooking with solid fuels, and
- diesel exhaust,etc.

What does BC do?

- Black carbon warms the Earth by absorbing heat in the atmosphere and by reducing albedo, (the ability to reflect sunlight) when deposited on snow and ice.
- BC is the strongest absorber of sunlight and heats the air directly. In addition, it darkens snow packs and glaciers through deposition and leads to melting of ice and snow.
- Regionally, BC disrupts cloudiness and monsoon rainfall and accelerates melting of mountain glaciers such as the Hindu Kush-Himalayan glaciers.

Life time

- Black carbon stays in the atmosphere for only several days to weeks.
- Thus the effects of BC on the atmospheric warming and glacier retreat disappear within months of reducing emissions.

How far India contributes to globe?

- According to estimates, between 25 and 35 percent of black carbon in the global atmosphere comes from China and India, emitted from the burning of wood and cow dung in household cooking and through the use of coal to heat homes.

Government Measures

- Project Surya has been launched to reduce black carbon in atmosphere by introducing efficient stove technologies, solar cookers, solar lamps and biogas plants.

17.3.7. Brown Carbon

- Brown carbon is a ubiquitous and unidentified component of organic aerosol which has recently come into the forefront of atmospheric research.
- Light-absorbing organic matter (other than soot) in atmospheric aerosols of various origins, e.g., soil humics, humic-like substances (HULIS), tarry materials from combustion, bioaerosols, etc.

Possible Sources of Brown Carbon are

- Biomass burning (possibly domestic wood burning) is shown to be a major source of brown carbon
- smoke from agricultural fires may be an additional source.
- "Brown carbon" is generally referred for greenhouse gases and "black carbon" for particles resulting from impure combustion, such as soot and dust.

17.4. CLIMATE FORCINGS

- Climate "forcings" are factors in the climate system that either increase or decrease the effects to the climate system.
- Positive forcings such as excess greenhouse gases warm the earth while negative forcings, such as the effects of most aerosols and volcanic eruptions, actually cool the earth.
- Atmospheric aerosols include volcanic dust, soot from the combustion of fossil fuels, particles from burning forests and mineral dust.
- Dark carbon-rich particles such as soot from diesel engines absorb sunlight and warm the atmosphere.
- Conversely, exhaust from high-sulphur coal or oil produce light aerosols that reflect sunlight back to space, producing a cooling effect. Aerosols that form naturally during volcanic eruptions cool the atmosphere. Large volcanic eruptions can eject enough ash into the atmosphere to lower

temperature for a year or more until the sulfate particles settle out of the atmosphere.

17.4.1. Forcing

Altering the Energy Balance

- The power of a process to alter the climate is estimated by its "radiative forcing," the change in the Earth's energy balance due to that process.
- Some climate forcings are positive, causing globally averaged warming, and some are negative, causing cooling. Some, such as from increased CO_2 concentration, are well known; others, such as from aerosols, are more uncertain.

Natural Forcings

- Natural forcings include changes in the amount of energy emitted by the Sun, very slow variations in Earth's orbit, and volcanic eruptions.
- Since the start of the industrial revolution, the only natural forcing with any long-term significance has been a small increase in solar energy reaching Earth. However, this change is not nearly enough to account for the current warming.

Human-Induced Forcings

- Climate forcing can also be caused by human activities. These activities include greenhouse gas and aerosol emissions from burning fossil fuels and modifications of the land surface, such as deforestation.

Human-Generated Greenhouse Gases

- Greenhouse gases are a positive climate forcing; that is, they have a warming effect. Carbon dioxide emitted from the burning of fossil fuel is presently the largest single climate forcing agent, accounting for more than half of the total positive forcing since 1750.

Human-Generated Aerosols

- Burning fossil fuels adds aerosols to the atmosphere. Aerosols are tiny particles in the atmosphere composed of many things, including water, ice, ash, mineral dust, or acidic droplets.
- Aerosols can deflect the Sun's energy and impact the formation and lifetime of clouds. Aerosols are a negative forcing; that is, they have a cooling effect.

Causes of Climate Change

- While natural forcings do exist, they are not significant enough to explain the recent global warming. Human activities are very likely responsible for most of the recent warming.

How to estimate the effect of each gas?

- Each gas's effect on climate change depends on three main factors:

1. How much of these gases are in the atmosphere?
    - Concentration, or abundance, is the amount of a particular gas in the air. Greenhouse gas concentrations are measured in parts per million, parts per billion, and even parts per trillion.
    - One part per million is equivalent to one drop of water diluted into about 13 gallons of liquid (roughly the fuel tank of a compact car).
2. How long do they stay in the atmosphere?
    - Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years.
    - All of these gases remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions.
3. How strongly do they impact global temperatures?
    - Some gases are more effective than others at making the planet warmer and "thickening the Earth's blanket (green house gas)".
    - For each greenhouse gases, a Global Warming Potential (GWP) has been calculated to reflect how long it remains in the atmosphere, on average, and how strongly it absorbs energy.

17.5. GLOBAL WARMING POTENTIAL

- Global warming potential describes the impact of each gas on global warming.
- The two most important characteristics of a GHG in terms of climate impact are how well the gas absorbs energy (preventing it from immediately escaping to space), and how long the gas stays in the atmosphere.
- The Global Warming Potential (GWP) for a gas is a measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide.
- Gases with a higher GWP absorb more energy, per pound, than gases with a lower GWP, and thus contribute more to warming Earth.

GWP & Lifetime of Green House Gases:

S. No	GAS	GWP (100-year)	LIFETIME (years)
1	Carbon di oxide	1	100
2	Methane	21	12
3	Nitrous oxide	310	120
4	Hydro fluoro carbons (HFCs)	140-11,700	1-270
5	Perfluoro carbons (PFCs)	6,500-9,200	800-50,000
6	Sulfur hexafluoride (SF6)	23,900	3,200

Carbon dioxide (CO_2) has a GWP of 1 and serves as a baseline for other GWP values.

- The larger the GWP, the more warming the gas causes. For example, methane's 100-year GWP is 21, which means that methane will cause 21 times as much warming as an equivalent mass of carbon dioxide over a 100-year time period.
- Methane (CH_4) has a GWP more than 20 times higher than CO_2 for a 100-year time scale. CH_4 emitted today lasts for only 12 years in the atmosphere, on average. However, on a pound-for-pound basis, CH_4 absorbs more energy than CO_2, making its GWP higher.
- Nitrous Oxide (N_2O) has a GWP 310 times that of CO_2 for a 100-year timescale. N_2O emitted today remains in the atmosphere for an average of 120 years.
- Chloro fluoro carbons (CFCs), hydro fluoro carbons (HFCs), hydro chloro fluoro carbons (HCFCs), perfluoro carbons (PFCs), and sulfur hexafluoride (SF6) are called high-GWP gases because, for a given amount of mass, they trap substantially more heat than CO_2.

17.6. RECEDING GLACIERS-A SYMPTOM OF GLOBAL CLIMATE CHANGE

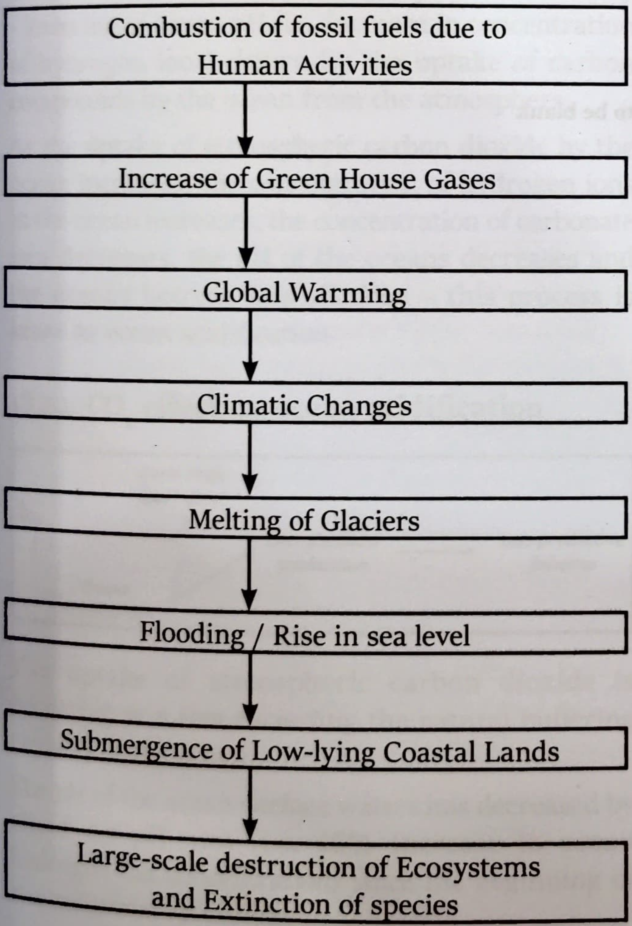
- 150 years ago there were 147 glaciers in Glacier National park, but today only 37 glaciers remain, and scientists predict that they are likely to melt by the year 2030. Similarly, glaciers all across the Himalayas and Alps are retreating and disappearing every year. There are almost 160,000 glaciers found in Polar Regions and high mountain environments. Therefore, researchers are increasingly using satellite remote sensors to routinely survey our world's glaciers in a fraction of the time.

17.6.1. Impact of glacial retreat

- The retreat of glaciers in the Andes and the Himalayas will have a potential impact on water supplies.

- Climate change may cause variations in both temperature and snowfall, causing changes in mass balance of a glacier.
- The Himalayas and other mountain chains of central Asia support large regions that are glaciated. These glaciers provide critical water supplies to dry countries such as Mongolia, western China, Pakistan and Afghanistan. The loss of these glaciers would have a tremendous impact on the ecosystem of the region.
- World's leading scientists predict that global warming may pose serious threat to national and global economy and the environment.
- The poor and low-lying countries will find it difficult to cope with the damages caused by changing climate and rise in sea level

17.6.2. Chain of events


Combustion of fossil fuels due to Human Activities
Increase of Green House Gases
Global Warming
Climatic Changes
Melting of Glaciers
Flooding / Rise in sea level
Submergence of Low-lying Coastal Lands
Large-scale destruction of Ecosystems and Extinction of species

17.7. CLIMATE TIPPING

- Climate Tipping Points, abbreviated as CTPs, serve as indicators within the broader climate system. Once these points are surpassed, they initiate self-sustaining warming, contributing to a cascading effect.
- Due to the 1.1-degree Celsius of global heating caused by human activities so far, it is possible that five critical tipping points have already been crossed, posing significant risks.
- Among these are the potential scenarios of the Greenland ice cap collapsing, leading to a substantial rise in sea levels, the disruption of a crucial current in the North Atlantic, which plays a vital role in providing rain for billions of people's food sources, and the sudden thawing of permafrost rich in carbon.
- At 1.5 degrees Celsius, five tipping points become possible.
- These include alterations in extensive northern forests, the potential loss of nearly all mountain glaciers, the die off of tropical coral reefs, and shifts in the west African monsoon.
- The nine global tipping points identified occur when temperatures rise beyond 2°C. These include the potential collapse of the Greenland, West Antarctic, and two parts of the East Antarctic ice sheets, as well as the partial and total collapse of the Atlantic Meridional Overturning Circulation (AMOC).
- Additionally, there is the risk of Amazon dieback, permafrost collapse, and winter sea ice loss in the Arctic.
- Ongoing research is also examining other potential tipping points, such as the loss of ocean oxygen and significant changes in the Indian summer monsoon.

CHAPTER - 18

OCEAN ACIDIFICATION

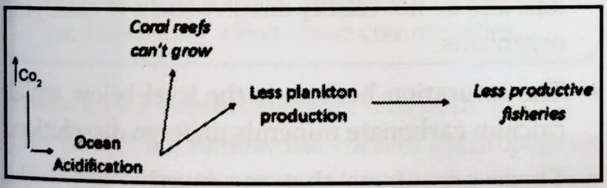
18.1. OCEAN ACIDIFICATION

Oceans are an important reservoir for CO_2, absorbing a significant quantity of it (one-third) produced by anthropogenic activities and effectively buffering climate change.

Ocean acidification is the change in ocean chemistry - lowering of ocean pH (i.e. increase in concentration of hydrogen ions) driven by the uptake of carbon compounds by the ocean from the atmosphere.

As the uptake of atmospheric carbon dioxide by the ocean increases, the concentration of hydrogen ions in the ocean increases, the concentration of carbonate ions decreases, the pH of the oceans decreases and the oceans become less alkaline – this process is know as ocean acidification.

18.1.1. CO_2 effect on ocean acidification



The uptake of atmospheric carbon dioxide is occurring at a rate exceeding the natural buffering capacity of the ocean.

The pH of the ocean surface waters has decreased by about 0.1 pH unit (i.e. 26% increase in ocean hydrogen ion concentration) since the beginning of the industrial revolution.

The ocean currently has a pH around 8.0 and is therefore 'basic' and it is nearly impossible, chemically, for all of it to actually become a pH less than 7.0. Why do we therefore refer to 'ocean acidification'?

That is because acidification is the direction of travel, the trend, regardless of the starting point. Acidification refers to lowering pH from any starting point to any end point on the pH scale.

Forms of calcium carbonate

Calcite and aragonite are two different forms of calcium carbonate.

1. Calcite is the mineral form found in the shells of planktonic algae, amoeboid protists, some corals, echinoderms, and some molluscs (e.g. oysters); it is relatively less soluble.
2. Aragonite is a more soluble form of calcium carbonate; it is found in most corals, most mollusks (small planktonic snails), as well as some species of algae.

18.1.2. Influence of other factors

Various factors can locally influence the chemical reactions of CO2 with sea water and add to the effects to ocean acidification. For example,

i. Acid rain

Acid rain can have a pH between 1 and 6 and has impact on surface ocean chemistry. It has major effect on ocean acidification locally and regionally but very small globally.

ii. Eutrophication

Coastal waters are also affected by excess nutrient inputs, mostly nitrogen, from agriculture, fertilizers and sewage. The resulting eutrophication leads to large plankton blooms, and when these blooms collapse and sink to the sea bed the subsequent respiration of bacteria decomposing the algae leads to a decrease in sea water oxygen and an increase in CO_2 (a decline in pH).

How it reacts?

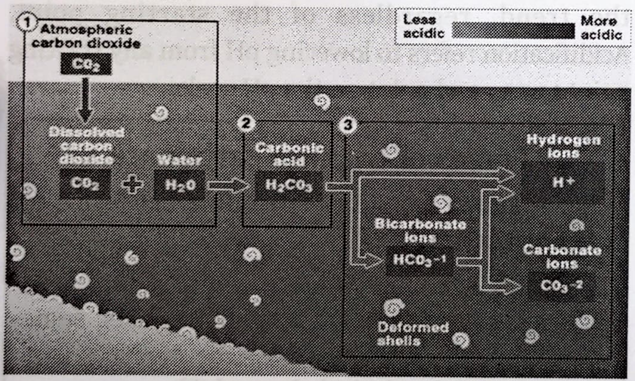
The term 'ocean acidification' summarizes several processes that occur when CO_2 reacts with sea water.

Two reactions are particularly important. Firstly, the formation of carbonic acid with subsequent release of hydrogen ions:

$$CO_2 \quad + \quad H_2O \qquad H_2CO_3 \rightleftharpoons H+ \rightleftharpoons HCO_3--$$

(Carbon dioxide) + (Water) (Carbonic acid) (Hydrogen ions) + (Bicarbonate ions)

OCEAN ACIDIFICATION



The above reaction and release of hydrogen ions increases acidity and thus pH level is reduced.

A second reaction, between carbonate ions, CO_2 and water produces bicarbonate ions.

The combined effect of both these reactions not only increases acidity but also lowers the availability of carbonate ions.

18.1.3. Effect of ocean acidification

Seawater absorbs CO_2 to produce carbonic acid (H_2CO_3), bicarbonate (HCO_3--) and carbonate ions (CO_{32}-).

These carbonate ions are essential to the calcification process that allows certain marine organisms to build their calcium carbonate shells and skeletons (e.g. hard tropical corals, cold water corals, molluscs, crustaceans, sea urchins, certain types of plankton, lobsters, etc).

However, increases in atmospheric CO_2 levels lead to decrease in pH level, increase in the concentration of carbonic acid and bicarbonate ions, causing a decrease in the concentration of carbonate ions.

Thus carbonate ions are less available and calcification is therefore harder to achieve, and may be prevented altogether. Imagine trying to build a house while someone keeps stealing your bricks.

This impact of ocean acidification may therefore have potentially catastrophic consequences for ocean life and many marine species of economic importance.

18.1.4. Mitigation

- Reducing CO_2
- promoting government policies to cap CO_2 emissions,
- eliminate offshore drilling,
- by advocating for energy efficiency and
- Alternative energy sources such as wind power, solar, etc.

18.1.5. Saturation horizons

- Deep, cold ocean waters are naturally under saturated with carbonate ions causing the shells of most calcifying organisms to dissolve.
- Surface waters are over saturated with carbonate ions and do not readily dissolve shells of calcifying organisms.
- The saturation horizon is the level below which calcium carbonate minerals undergo dissolution.
- Those organisms that can survive below the saturation horizon do so due to special mechanisms to protect their calcium carbonate from dissolving.
- As ocean acidification causes this horizon to rise vertically in the water column so more and more calcifying organisms will be exposed to under saturated water and thus vulnerable to dissolution of their shells and skeletons.

- The saturation horizon of calcite occurs at a greater ocean depth than that for aragonite, but both horizons have moved closer to the surface presently when compared to the 1800s.

18.1.6. Ocean acidification and the short and long-term fate of carbon in the system

On long timescales (>100,000 years) there is a natural balance maintained between the up-take and release of CO_2 on Earth; the CO_2 produced by volcanoes, the main natural source of CO_2, is taken up by the production of organic matter by plants and by rock weathering on land.

UPWELLING

Surface Coastal regions periodically experience upwelling events where deeper ocean water circulates onto continental shelves and near-shore areas.

- This exposes the productive upper ocean ecosystems to colder water containing more nutrients & more CO_2.
- As ocean acidification makes the upper oversaturated layer of sea water shallower each year, these natural upwelling events will more often cause undersaturated water to well up and flow to the shore.
- Coastal marine organisms that form shells are unaccustomed to such events, and periodic exposures to these significantly different conditions may affect these communities.

However, rock weathering takes tens of thousands of years so will not remove the current anthropogenic input of CO_2 to the atmosphere and ocean fast enough.

On shorter time scales (>1,000 years), the ocean has an internal stabilizing feedback linking the ocean carbon cycle to the underlying carbonate rich sediment known as carbonate compensation.

The upper layers of the ocean tend to be supersaturated with $CaCO_3$ so little dissolution takes place, whilst the deep ocean is undersaturated and carbonate readily dissolves.

The first boundary between these two states is known as the lysocline, the depth at which dissolution strongly increases in the deep ocean.

The $CaCO_3$ in the form of dead shells sink to the sea bed. If it is of shallow water depth, the majority is buried in the sediment and trapped for a long time, but where the shells sink in deep water nearly all the $CaCO_3$ is dissolved, thereby not locking the carbon away for millions of years.

The current increased rate of dissolution of atmospheric CO_2 into the ocean results in an imbalance in the carbonate compensation depth (CCD), the depth at which all carbonate is dissolved.

As the pH of the ocean falls, it results in a shallowing of the lysocline and the CCD, thus exposing more of the shells trapped in the sediments to understaturated conditions causing them to dissolve, which will help buffer ocean acidification but over a long time scale of a thousand years.

18.1.7.Winners and losers

- The growth and level of photosynthesis of certain marine phytoplankton and plant species may increase with higher CO_2 levels, but this is by no means a general rule.
- For others, higher CO_2 and rising acidity may have either negative or neutral effects on their physiology.
- Therefore, particular marine plants will be 'winners', while others will be 'losers' and some may show no signs of change but change is inevitable.
- A reduction in atmospheric CO_2 levels is essential to halt ocean acidification before it is too late.

◆

CHAPTER - 19

OZONE DEPLETION

Ozone is a natural gas; it is an allotrope of oxygen consisting of three atoms of oxygen bound together in a non-linear fashion. The chemical symbol of ozone is O_3.

It is found in two different layers of the atmosphere. Ozone in the troposphere is “bad” because it dirties the air and helps to form smog, which is not good to breathe. Ozone in the stratosphere is “good” because it protects life on Earth by absorbing some of the sun’s harmful Ultra Violet (UV) rays.

The ozone layer is very important because the configuration of the ozone molecule and its chemical properties are such that ozone efficiently absorbs ultraviolet light, thus acting like a sun-screen.

> The UV rays cause direct damage to the genetic material or DNA of animal and plant cells. Exposure of mammals to UV light has been shown to act on the immune system, thereby making the body more susceptible to diseases.

In doing so, ozone protects oxygen at lower altitudes from being broken up by the action of ultraviolet light and also keeps most of the ultraviolet radiation from reaching the earth’s surface.

It helps in reducing the risks of mutation and harm to plant and animal life. Too much UV rays can cause skin cancer and will also harm all plants and animals. Life on Earth could not exist without the protective shield of the ozone layer.

How ozone is measured?

- The ozone measurement instruments and techniques are varied. Some of them are the Dobson spectrophotometer and the filter ozonometer called M83, and total ozone mapping spectrometer (TOMS) in the Nimbus-7 satellite.

The Umheher technique

- The most common measure of total ozone abundance is the Dobson unit (named after the pioneering atmospheric physical Gordon Dobson) which is the thickness of the ozone column (compressed at Standard Temperature and Pressure (STP)) in milli-centimeters. At STP one Dobson unit is equal to 2.69x1020 molecules per square meter.

19.1. OZONE DEPLETION

19.1.1. Change in equilibrium

- The equilibrium between the formation and destruction of ozone, has been upset by the influx of several substances into the atmosphere which react with ozone and destroy it.
- The rate at which ozone is being destroyed is much faster than the rate at which it is being formed.
- It implies that there is a significant decrease in the concentration of ozone in a particular region of the atmosphere, hence the name ‘Ozone Depletion’.

- The best example of such an Ozone Depletion is the atmosphere over the Antarctic which has only about 50 percent of the ozone that originally occurred there. The actual realization of ozone-depletion came only in 1985.

Sources

19.1.2. Chlorofluorocarbons (CFCs):

CFCs molecules are made up of chlorine, fluorine and carbon.

Where it is used?

They are used as refrigerants, propellents in aerosol sprays, foaming agents in plastic manufacturing, fire extinguishing agents, solvents for cleaning electronic and metallic components, for freezing foods etc .

Two-thirds of CFC is used as refrigerants while one-third is used as blowing agents in foam insulation products.

Why CFCs are used?

CFCs has a wide and varied application due to its properties like non-corrosiveness, non-inflammability, low toxicity and chemical stability, etc.

Lifetime & removal of CFCs

Unlike other chemicals, CFCs cannot be eliminated from the atmosphere by the usual scavenging processes like photodissociation, rain-out and oxidation.

In fact, the residence time of CFCs in the atmosphere estimated to be between 40 and 150 years. During this period, the CFCs move upwards by random diffusion, from the troposphere to the stratosphere.

The escape of CFCs

The CFCs enter into the atmosphere by gradual evaporation from their source. CFCs can escape into the atmosphere from a discarded refrigerator. Since the CFCs are thermally stable they can survive in the troposphere. But in the stratosphere, they are exposed to UV radiation.

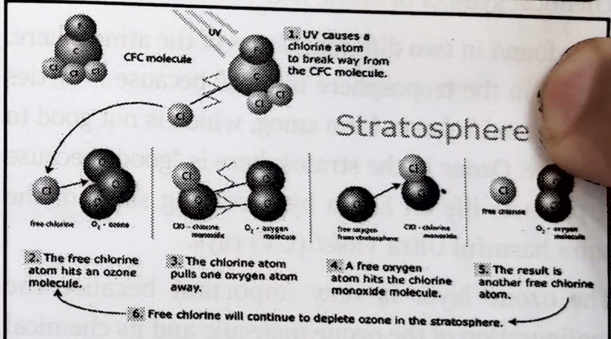
The chemical reaction

The molecules of CFCs when exposed to UV radiation break up, thus freeing chlorine atoms. A free chlorine atom reacts with an ozone molecule to form chlorine monoxide (ClO). The molecules of chlorine monoxide further combine with an atom of oxygen. This reaction results in the formation of an oxygen molecule (O_2) and reformation of the free chlorine atom (Cl).

Chlorine + → Chlorine monoxide + oxygen
Chlorine monoxide → Chlorine + Oxygen
+ monoxide (o)

Net reaction:

ozone + → oxygen + oxygen
monoxide (o)


UV
CFC molecule
1. UV causes a chlorine atom to break way from the CFC molecule.
Stratosphere
free chlorine
O_3 - ozone
ClO - chlorine monoxide
O_2 - oxygen molecule
free oxygen from stratosphere
ClO - chlorine monoxide
free chlorine
O_2 - oxygen molecule
2. The free chlorine atom hits an ozone molecule.
3. The chlorine atom pulls one oxygen atom away.
4. A free oxygen atom hits the chlorine monoxide molecule.
5. The result is another free chlorine atom.
6. Free chlorine will continue to deplete ozone in the stratosphere.

CFC Ozone Depletion

The depletion of O3 is catalystic. The element that destroys O3 (i.e chlorine) is being reformed at the end of cycle. A single chlorine atom destroys thousands of ozone molecules before encountering reactive nitrogen or hydrogen compounds that eventually return chlorine to its reservoirs.

CFC substitutes – characteristics

- The substitute for CFCs should be safe, low cost, increased energy efficiency of CFC replacement technology, effective refrigerants with low ozone layer depletion potential (ODP) and low global warming potential (GWP).
- CFC-12 (R-12) is a widely used refrigerant. HFC 134a (R-134a) is the most promising alternative (R-143a) and (R-152a) can also be used.

19.1.3. Nitrogen Oxides:

Sources

The sources of nitrogen oxides are mainly explosions of thermonuclear weapons, industrial emissions and agricultural fertilizers.

The chemical reaction

Nitric oxide (NO) catalytically destroys ozone.

Nitric oxide + ozone   Nitrogen dioxide + Oxygen
Nitrogen dioxide + monoxide   Nitric oxide + Oxygen

The escape of N_2O

Nitrous oxide (N_2O) is released from solid through denitrification of nitrates under anaerobic conditions and nitrification of ammonia under aerobic conditions. This N_2O can gradually reach the middle of the stratosphere, where it is photolytically destroyed to yield nitric oxide which in turn destroys ozone.

Other substances:

Bromine containing compounds called halons and HBFCs, i.e. hydrobromo fluorocarbons [both used in fire extinguishers and methyl bromide (a widely used pesticide)]. Each bromine atom destroys hundred times of more ozone molecules than what a chlorine atom does.

Bromine + ozone → Bromine monoxide + Oxygen
Bromine monoxide + chlorine monoxide → Oxygen + Bromine + chlorine

Bromine (Br) combines with ozone forming bromine monoxide (BrO) and Oxygen (O2). The BrO further reacts with chlorine monoxide (ClO) to give oxygen (O2) and free atoms of bromine (Br) and chlorine (Cl). This free atoms can further react with ozone.

Sulphuric acid particles: These particles free chlorine from molecular reservoirs, and convert reactive nitrogen into inert forms thus preventing the formation of chlorine reservoirs.

Carbon tetrachloride (a cheap, highly toxic solvent) and methyl chloroform (used as a cleaning solvent for clothes and metals, and a propellant in a wide range of consumer products, such as correction fluid, dry cleaning sprays, spray adhesives) and other aerosols.

Monitoring the Ozone Layer

Some organizations that help in monitoring the atmosphere and form a network of informations communication about the atmosphere, including ozone layer monitoring are:

- World Meteorological Organization (WMO)
- World Weather Watch (WWW)
- Integrated Global Ocean Services Systems (IGOSS)
- Global Climate Observing System (GCOS)

19.1.4. Role of polar stratospheric clouds in ozone depletion.

There are three types of stratospheric clouds. They are:

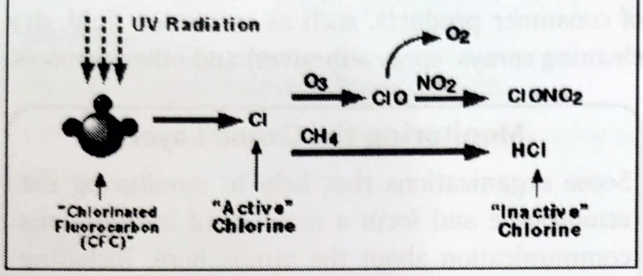
1. Nacreous clouds extend from 10 to 100km in length and several kilometers in thickness. They are also called 'mother-of-pearl' clouds due to their glow with a sea-shell like iridescence.
2. The second type of clouds contain nitric acid instead of pure water.
3. The third type of clouds have the same chemical composition as nacreous clouds, but form at a slower rate, which results in a larger cloud with no iridescence.

The chlorine released by the breakdown of CFCs exists initially as pure chlorine or as chlorine monoxide (active chlorine / instable) but these two forms react further to form compounds Chlorine nitrate and HCL that are stable (inactive chlorine).

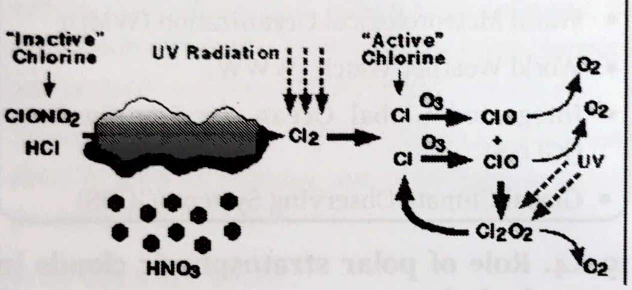
Chlorine + methane → HCl + methyliumcation (CH3)
Chlorine monoxide → Chlorine nitrate + Nitrogen dioxide

The stable compounds HCL and $CLONO_2$ are reservoirs of chlorine, and therefore for chlorine to take part in reactions of any sort, it has to be freed.

Conversionof Chlorine from "Active" to "Inactive" States



Effect of Polar Stratospheric Clouds



There is a correlation exist between the cycle of ozone depletion and the presence of polar stratospheric clouds (PSCs) i.e. the ice particles of the cloud provided substrates for chemical reactions which freed chlorine from its reservoirs. Usually the reaction between HCl and $ClONO_2$ is very slow, but this reaction occurs at a faster rate in the presence of a suitable substrate which is provided by the stratospheric clouds at the poles.

HCl + Chlorine nitrate ⟶ molecular chlorine

It results in the formation of molecular chlorine and nitric acid. The molecular chlorine formed in the above reaction can be broken down to atomic chlorine and the ozone depletion reaction would continue. The PSCs not only activate chlorine, but they also absorb reactive nitrogen. If nitrogen oxides were present they would combine with chlorine monoxide to form a reservoir of chlorine nitrate ($ClONO_2$).

Dimer of chlorine monoxide: Stratospheric chlorine monoxide reacts with itself forming a dimer Cl2O2. This dimer is easily dissociated by sunlight, giving rise to free chlorine atoms which can further react to destroy ozone.

> Every spring, a hole as big as the USA develops in the ozone layer over Antarctica, in the South Pole. A smaller hole develops each year over the Arctic, at the North Pole. And there are signs that the ozone layer is getting thinner all over the planet.

19.1.5. Why is the Ozone Depletion predominant at the Antarctic?

- The Antarctic stratosphere is much colder. The low temperature enables the formation of Polar stratospheric Clouds (PSCs), below 20 km.
- Ozone absorbs sunlight, causing the characteristic increase in temperature with increase in altitude in the stratosphere. If ozone is being depleted, the air becomes cooler, further adding to the favourable conditions for the formation of PSCs and stabilization of the vortex. The vortex is a ring of rapidly circulating air that confines the ozone depletion in the Antarctic region.
- The longetivity of the Antarctic vortex is another factor, enhancing favourable conditions for the depletion of ozone. The vortex remains, in fact, throughout the polar winter, well into midspring whereas the vortex in the Arctic disintegrates by the time the polar spring (March-April) arrives.
- Typical happenings in the winter months leading to the Ozone Depletion over the Antarctic.
- In June Antarctic winter begins, the vortex develops and the temperature falls enough for the clouds to form.
- During July and August PSCs denitrify and dehydrate the stratosphere through precipitation, hydrochloric acid and chlorine nitrate react on cloud surfaces to free chlorine and winter temperatures drops to their lowest point.
- In September sunlight returns to the centre of the vortex as the austral spring begins and PSCs disappear because of increasing temperature. ClO-ClO and ClO-BrO catalystic cycles destroy ozone.

- During October lowest levels of ozone are reached.
- In November, Polar vortex breaks down, ozone-rich are from the mid-latitudes replenishes the Antarctic stratosphere and ozone-poor air spreads over the southern hemisphere.

19.1.6. Arctic Ozone Depletion

- The Ozone Depletion has been increasingly evident over the Arctic as well.
- The Arctic Ozone Depletion which swept across Britain in March 96 was the greatest depletion of ozone ever seen in the northern hemisphere.
- Scientists claim that it had been caused, in past, by a dramatic cooling of the upper atmosphere in the northern latitudes over.

  The ozone depletion over the northern hemisphere has been increasing steadily since the winter of 1992.
- Apart from the build-up of ozone depleting chemicals, the main cause is the increasing cold temperature in the arctic stratosphere which encourages the formulation of PSCs.

19.1.7. Environmental Effects of Ozone Depletion

Decrease in the quantity of total-column ozone; tend to cause increased penetration of solar UV-B radiation (290-315nm) to the earth's surface. UV-B radiation is the most energetic component of sunlight reaching the earth's surface. It has profound effects on human health, animals, plants, micro-organisms, materials and on air quality.

Effects of human and animal health

- Potential risks include an increase in the incidence of and morbidity from eye diseases, skin cancer and infectious diseases.
- UV radiation has been shown in experimental systems to damage the cornea and lens of the eye. Experiments in animals show that UV exposure decreases the immune response to skin cancers, infectious agents and other antigens and can lead to unresponsiveness upon repeated challenges.
- In susceptible (light-skin coloured) populations, UV-B radiations is the key risk factor for development of non-melanoma skin cancer (NMSC).

Effects on terrestrial plants

- Psychological and developmental processes of plants are affected by UV-B radiation.
- Response to UV-B also varies considerably among species and also cultivars of the same species. In agriculture, this will necessitate using more UV-B tolerant cultivars and breeding new ones.
- In forests and grasslands, this is likely to result in changes in the composition of species; therefore there are implications for the biodiversity in different eco-systems.
- Indirect changes caused by UV-B such as changes in plant form, biomass allocation to parts of the plant, timing of developmental phases and second metabolism may be equally or sometimes more important that the damaging effects of UV-B.

Effects on aquatic ecosystems

- Exposure to solar UV-B radiation has been shown to affect both orientation mechanisms and motility in phytoplankton, resulting in reduced survival rates for these organisms.
- Solar UV-B radiation has been found to cause damage in the early developmental stages of fish, shrimp, crab, amphibians and other animals. The most severe effects are decreased reproductive capacity and impaired larval development.

Effects on bio-geochemical cycles

- Increases in solar UV radiation could affect terrestrial and aquatic bio-geochemical cycles, thus, altering both sources and sinks of greenhouse and chemically important trace gases.
- These potential changes would contribute to biosphere atmosphere feedbacks that reinforce the atmospheric build-up of these gases.

Effects on air quality

- Reduction in stratospheric ozone and the concomitant increase in UV-B radiation penetrating to the lower atmosphere result in higher photo dissociation rates of key trace gases that control the chemical reactivity of the troposphere.
- This can increase both production and destruction of ozone (O_3) and related oxidants such as hydrogen peroxide (H_2O_2), which are known to have adverse effects on human health, terrestrial plants, and outdoor materials.
- Changes in the atmospheric concentrations of the hydroxyl radical (OH) may change the atmospheric lifetimes of climatically important gases such as methane (CH_4) and the CFC substitutes.)
- Increased tropospheric reactivity could also lead to increased production of particulates such as cloud condensation nuclei, from the oxidation and subsequent nucleation of sulphur, of both antropogenic and natural origin (e.g. carbonyl sulphide and dimethylsulphide.

Effects on materials

- Synthetic polymers, naturally occurring bio-polymers, as well as some other materials of commercial interest are adversely affected by solar UV radiation.
- The application of these materials, particularly, plastics, in situations which demand routine exposure to sunlight is only possible through the use of light-stabilizers and / or surface treatment to protect them from sunlight.
- Any increase in solar UV-B content due to partial ozone depletion will therefore accelerate the photogradation rates of these materials, limiting their life outdoors.

19.2. THE OZONE DEPLETING SUBSTANCES RULES

- The Ozone Depleting Substances (Regulation and Control)Rules, 2000 under the Environment (Protection)Act, in July 2000.
- These Rules set the deadlines for phasing out of various ODSs, besides regulating production, trade import and export of ODSs and the product containing ODS.
- The Ozone Depleting Substances (Regulation and Control) Rule, 2000 were amended in 2001, 2003, 2004 and 2005 to facilitate implementation of ODS phase-out at enterprises in various sectors.
- These Rules prohibit the use of CFCs in manufacturing various products beyond 1st January 2003 except in metered dose inhaler and for other medical purposes.
- Similarly, use of halons is prohibited after 1st January 2001 except for essential use. Other ODSs such as carbon tetrachloride and methylchoroform and CFC for metered dose inhalers can be used upto 1st January 2010.
- Further, the use of methyl bromide has been allowed upto 1st January 2015. Since HCFCs are used as interim substitute to replace CFC, these are allowed upto 1st January 2040.

Ozone Depleting Substances (Regulation Control) Amendment Rules, 2019

- Under the Environment (Protection) Act of 1986, the Ozone Depleting Substances (Regulation and Control) Amendment Rules, 2019, have been published.
- According to the Ozone Depleting Substances (Regulation and Control) Amendment Rules, 2019, the Ministry of Environment, Forest, and Climate Change (MoEFCC) informed the issuance of import licenses for HCFC-141b is prohibited beginning on January 1, 2020.
- India effectively addressed the task of entirely phasing out Hydrochlorofluorocarbon (HCFC)-141b, a chemical utilized by foam-producing businesses, by January 1, 2020.
- India has made a deliberate choice to shift away from ozone-depleting substances (ODSs) in favor of eco-friendly and energy-efficient technologies.

CHAPTER - 20

IMPACT OF CLIMATE CHANGE

20.1. AGRICULTURE AND FOOD SECURITY

- Climate Change can affect crop yield as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests.
- Rise in temperatures caused by increasing green house gases is likely to affect crops differently from region to region. For example, moderate warming (increase of 1 to 3°C in mean temperature) is expected to benefit crop yields in temperate regions, while in lower latitudes especially seasonally dry tropics, even moderate temperature increases (1 to 2°C) are likely to have negative impacts for major cereal crops. Warming of more than 3°C is expected to have negative effect on production in all regions.
- The Sixth Assessment Report of the IPCC, 2023 concluded that climate change would hit the poorest countries severely in terms of reducing the agricultural products.
- The Report claimed that crop yield would be reduced in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect/pest incidence.
- In South Asia losses of many regional staples, such as rice, millet and maize could top 10 per cent by 2030.
- As a result of thawing of snow, the amount of arable land in high-latitude region is likely to increase by reduction of the amount of frozen lands.
- At the same time arable land along the coast lines are bound to be reduced as a result of rising sea level.
- Erosion, submergence of shorelines, salinity of the water table due to the increased sea levels, could mainly affect agriculture through inundation of low lying lands.
- In a recent study, the International Commission for Snow and Ice (ICSE) reported that Himalayan glaciers - that are the principal dry-season water sources of Asia's biggest rivers - Ganges, Indus, Brahmaputra, Yangtze, Mekong, Salween and Yellow - are shrinking quicker than anywhere else and that if current trends continue they could disappear altogether by 2035.
- If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity will be manifold.

20.1.1. Impacts on Indian agriculture

- A large part of the arable land in India is rain-fed, the productivity of agriculture depends on the rainfall and its pattern.

- Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall but also by shifts in the timing of the rainfall.
- Any change in rainfall patterns poses a serious threat to agriculture, and therefore to the economy and food security.
- Summer rainfall accounts for almost 70 per cent of the total annual rainfall over India and is crucial to Indian agriculture.
- However, studies predict decline in summer rainfall by the 2050s.
- Semi arid regions of western India are expected to receive higher than normal rainfall as temperatures soar, while central India will experience a decrease of between 10 and 20 per cent in winter rainfall by the 2050s.
- Relatively small climate changes can cause large water resources problems particularly in arid and semi arid regions such as northwest India.
- Productivity of most crops may decrease due to increase in temperature and decrease in water availability, especially in Indo-Gangetic plains.
- This apart, there would be a decline in the productivity of rabi as compared to kharif season crops.
- Rising temperature would increase fertilizer requirement for the same production targets and result in higher GHG emissions, ammonia volatilization and cost of crop production.
- Increased frequencies of droughts, floods, storms and cyclones are likely to increase agricultural production variability.

20.2. WATER STRESS AND WATER INSECURITY

- Lack of access to water is a perturbing issue, particularly in developing countries.
- Climate change is expected to exacerbate current stresses on water resources.
- By 2022, between 2 and 3 billion people are projected to be exposed to increased water stress due to climate change.
- Spreading water scarcity is contributing to food insecurity and heightened competitions for water both within and between countries.
- As the world population expands and the consumption of water spirals upwards, water problems are bound to intensify.
- Increase in temperature due to climate change has been widespread over the globe.
- Warming has resulted in decline in mountain glaciers and snow cover in both hemispheres and this is projected to accelerate throughout the 21st century.
- This will in turn lead to reducing water availability, hydropower potential, and would change the seasonal flow of rivers in regions supplied by melt water from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes).
- By 2050s freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.
- A warmer climate will accelerate the hydrologic cycle, altering rainfall, magnitude and timing of run-off.
- Available research suggests a significant future increase in heavy rainfall events in many regions, while in some regions the mean rainfall is projected to decrease.
- The frequency of severe floods in large river basins has increased during the 20th century.
- Increasing floods poses challenges to society, physical infrastructure and water quality.
- Rising temperatures will further affect the physical, chemical and biological properties of fresh water lakes and rivers, with predominantly adverse impacts on many individual fresh water species, community composition and water quality.
- In coastal areas, sea level rise will exacerbate water resource constraints due to increased salinisation of groundwater supplies.

Do you know?

2019 IPCC Special Report "Climate Change and Land" states that extreme weather and climate or slow-onset events may lead to increased displacement, disrupted food chains, threatened livelihoods, and could contribute to exacerbated stresses for conflict.

.1. Impacts on water situation in India

- Water resources will come under increasing pressure in the Indian subcontinent due to the changing climate.
- The Himalayan glaciers are a source of fresh water for perennial rivers, in particular the Indus, Ganga, and Brahmaputra river systems.
- In recent decades, the Himalayan region seems to have undergone substantial changes as a result of extensive land use (e.g. deforestation, agricultural practices and urbanization), leading to frequent hydrological disasters, enhanced sedimentation and pollution of lakes.
- There is evidence that some Himalayan glaciers have retreated significantly since the 19th century.
- Available records suggest that the Gangotri glacier is retreating about 38 m per year.
- Glacial melt is expected to increase under changed climate conditions, which would lead to increased summer flows in some river systems for a few decades, followed by a reduction in flow as the glaciers disappear.
- As a result of increase in temperature significant changes in rainfall pattern have been observed during the 20th century in India.
- A serious environmental problem has also been witnessed in the Indo-Gangetic Plain Region (IGPR) in the past whereby different rivers (including Kosi, Ganga, Ghaghara, Son, Indus and its tributaries and Yamuna) changed their course a number of times.
- The recent devastating floods in Nepal and Bihar due to change of course of River Kosi is a case in point.
- Available study suggests that food production has to be increased to the tune of 400 mt by 2035 in order to feed India's ever-growing population, which is likely to reach 1.50 billion by the year 2035.
- The total foodgrain production has to be increased be double by 2050 to meet the requirement.
- It is feared that the fast increasing demand for food in the next two or three decades could be quite grim particularly in view of the serious problem of soil degradation and climate change.
- The rise in population will increase the demand for water leading to faster withdrawal of water and this in turn would reduce the recharging time of the water tables.
- As a result, availability of water is bound to reach critical levels sooner or later. During the past four decades, there has been a phenomenal increase in the growth of groundwater abstraction structures.
- Growing demand of water in agriculture, industrial and domestic sectors, has brought problems of overexploitation of the groundwater resource to the fore.
- The falling groundwater levels in various parts of the country have threatened the sustainability of the groundwater resources.
- At present, available statistics on water demand shows that the agriculture sector is the largest consumer of water in India.
- About 70% of the available water is used for agriculture alone. If used judiciously, the demand may come down to about 58% by the year 2050, though agriculture will still remain the largest consumer.
- In order to meet this demand, augmentation of the existing water resources by development of additional sources of water or conservation of the existing resources and their efficient use will be needed.

- It is evident that the impact of global warming threats are many and alarming.
- Water security in terms of quantity and quality pose problems for both developed and developing countries.
- However, the consequences of future climatic change may be felt more severely in developing countries such as India, whose economy is largely dependent on agriculture and is already under stress due to current population increase and associated demands for energy, freshwater and food.

20.3. RISE IN SEA LEVELS

- Sea level rise is both due to thermal expansion as well as melting of ice sheets.
- Satellite observations available since the early 1990s show that since 1993, sea level has been rising at a rate per year, significantly higher than the average during the previous half-century.
- IPCC predicts that sea levels could rise rapidly with accelerated ice sheet disintegration.
- Global temperature increases of 3-4°C could result in 330 million people being permanently or temporarily displaced through flooding.
- Warming seas will also fuel more intense tropical storms.

20.3.1. Impacts on Coastal States in India

- The coastal states of Maharashtra, Goa and Gujarat face a grave risk from the sea level rise, which could flood land (including agricultural land) and cause damage to coastal infrastructure and other property.
- Goa will be the worst hit, losing a large percentage of its total land area, including many of its famous beaches and tourist infrastructure.
- Mumbai's northern suburbs like Versova beach and other populated areas along tidal mud flats and creeks are also vulnerable to land loss and increased flooding due to sea level rise.
- Flooding will displace a large number of people from the coasts putting a greater pressure on the civic amenities and rapid urbanisation.
- Sea water percolation due to inundations can diminish freshwater supplies making water scarcer.
- The states along the coasts like Orissa will experience worse cyclones. Many species living along the coastline are also threatened.
- The coral reefs that India has in its biosphere reserves are also saline sensitive and thus the rising sea level threatens their existence too, not only the coral reefs but the phytoplankton, the fish stocks and the human lives that are dependent on it are also in grave danger.
- People living in the Ganges Delta share the flood risks associated with rising sea levels.

20.4. ECOSYSTEMS AND BIO-DIVERSITY

- Climate Change has the potential to cause immense biodiversity loss, affecting both individual species and their ecosystems that support economic growth and human well being.
- The projected extinctions of flora and fauna in the future will be human driven i.e. due to adverse impact of human activities.
- According to International World Wildlife Fund (WWF) species from the tropics to the poles are at risk.
- Many species may be unable to move to new areas quickly enough to survive changes that rising temperatures will bring to their historic habitats.
- WWF asserted that one-fifth of the world's most vulnerable natural areas may be facing a "catastrophic" loss of species.

- It have catastrophic impact on the marine ecosystems. They will be affected not only by an increase in sea temperature and changes in ocean circulation, but also by ocean acidification, as the concentration of dissolved carbon dioxide (carbonic acid) rises.
- This is expected to negatively affect shell forming organisms, corals and their dependent ecosystems.

IMPACTS ON INDIA'S BIODIVERSITY

India is a land of mega-biodiversity, encompassing features from glaciers to deserts. However, climate change is posing grave threat to its ecosystems.

- Mountain ecosystems are hot spots of biodiversity. However, temperature increases and human activities are causing fragmentation and degradation of mountain biodiversity.
- The Himalayan Ecosystem is considered as the lifeline not only to India but also to our neighbouring countries such as China, Pakistan, Nepal, owing to the perennial rivers that arise out of the melting glaciers.
- It is home to the largest amount of glaciers after the North and the South Poles. However, climate change is threatening this life giver drastically.
- It is also predicted that there will be an increase in the phenomenon of Glacial Lake Outburst Floods (GLOFs) in the eastern and the central Himalayas, causing catastrophic flooding downstream, with serious damage to 'life, property, forests, farms, and infrastructure'.
- The melting glaciers of the Himalayas have a serious impact given the fact that they give rise to the perennial rivers that further flourishes the agriculture.
- The Himalayan rivers are closely interlinked with the Indo-Gangetic Ecosystem, which is primarily an agricultural ecosystem, nearly 65-70% of Indians having agriculture as their primary occupation.
- The National Environment Policy, 2020 states that the Indian Desert Ecosystems (arid and semi-arid region) occupies 127.3 mha (38.8%) of the country's geographical area and spreads over 10 states.
- The Indian desert fauna is extremely rich in species diversity of mammals and winter migratory birds.
- Recent studies have shown that deserts have shown signs of expansion, thus leading to a process called desertification.
- The climate patterns have altered the natural attributes of a desert region; for example the floods in the desert district of Barmer in Rajasthan in 2006.
- Coastal and Marine Ecosystem is one of the assets of India.
- The mangrove forests (wetlands) of the rivers and the coasts acts as carbon sink as well as a habitat for a unique and diverse species of plants and animals.
- The wetlands act as a natural barrier to flooding (that may be caused by the rising sea levels) and cyclones.
- The most explicit event in the perspective of climate change affecting the marine ecosystem is the example of coral bleaching.
- In the Peninsular India, even the rivers of the Peninsula are dependent on the monsoons, thus the Peninsular Ecosystem is basically a monsoon dependent ecosystem.
- India is heavily dependent on the monsoon to meet its agricultural and water needs, and also for protecting and propagating its rich biodiversity. Climate change is linked with the changing patterns observed in the monsoons of India.

20.6. CLIMATE CHANGE AND HEALTH

- Climate change poses a host of threats to the survival of mankind.
- Each year, about 3.2 million people die from causes attributable to air pollution, 1.8 million from diarrhoea resulting from lack of access to clean water supply, sanitation, and poor hygiene, 3.5 million from malnutrition and approximately 60,000 in natural disasters.
- A warmer and more variable climate would result in higher levels of some air pollutants, increased transmission of diseases through unclean water and through contaminated food.
- Climate change has a direct impact on human health.
- For example, the warmer the climate the likelihood of its impact on human health becomes worse.
- It is anticipated that there will be an increase in the number of deaths due to greater frequency and severity of heat waves and other extreme weather events.
- Climate change and the resulting higher global temperatures are causing increasing frequency of floods and droughts leading to the risk of disease infections.
- Lack of freshwater during droughts and contamination of freshwater supplies during floods compromise hygiene, thus increasing rates of diarrhoeal disease.
- Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in hydrological cycle.
- Flooding also creates opportunities for breeding of disease carrying insects such as mosquitoes.
- Areas affected by frequent floods and drought conditions also witness large scale migration of populations to relatively stable regions leading to overcrowding and unhygienic conditions resulting in transmission of diseases like Japanese encephalitis and malaria.
- Climate change is a major factor in the spread of infectious diseases. Diseases, confined to one specific geographic region spread to other areas.
- The World Health Organization (WHO) in their studies have indicated that due to rising temperatures, malaria cases are now being reported for the first time from countries like Nepal and Bhutan.
- It has also been predicted that an additional 200-300 million people could be exposed to malaria- a disease that claims around 61900 lives annually.
- Dengue fever is already in evidence at higher levels of elevation in Latin America and parts of East Asia.
- Studies suggest that climate change may swell the population at risk of malaria in Africa by 90 million by 2030, and the global population at risk of dengue by 2 billion by 2080s.
- Rising temperatures and changing patterns of rainfall are projected to decrease crop yields in many developing countries, stressing food supplies. This will ultimately translate into wider prevalence of malnutrition/ undernutrition. In some African countries, yields from rain-fed agriculture could be reduced by up to 50 per cent by 2020.
- Emission of the Green House Gases have been responsible for the depletion of ozone layer, which protects the Earth from the harmful direct rays of the sun. Depletion of stratospheric ozone results in higher exposure to the ultra violet rays of the sun, leading to an increase in the incidents of skin

cancer. It could also lead to an increase in the number of people suffering from eye diseases such as cataract. It is also thought to cause suppression of the immune system.

- The projections by WHO and IPCC suggest that the negative effects of climate change on health are greater.
- In addition, the negative effects are concentrated on poor populations that already have compromised health prospects, thus widening the inequality gap between the most and the least privileged.
- The balance of positive and negative health impacts will vary from one location to another, and will alter over time as temperatures continue to rise.

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